MORS
MILITARY OPERATIONS RESEARCH SOCIETY

64th MORS Symposium

US Army Combined Arms Center
Fort Leavenworth, Kansas
18, 19, 20 June 1996

Leveraging Technology for the Military Analyst

Framing the Analysis ✦ Organizing the Data ✦ Exercising the Tools ✦ Conducting the Analysis

Final Program and Book of Abstracts

Sponsored by:

The Deputy Under Secretary of the Army
(Operations Research)

The Director, Assessment Division
Office of the Chief of Naval Operations

Director of Modeling, Simulation and Analysis
Deputy Chief of Staff, Plans and Operations
Headquarters, USAF

Commanding General
Marine Corps Combat Development Command

The Director for Force Structure, Resource and Assessment
The Joint Staff

Director, Program Analysis and Evaluation
Office Secretary of Defense

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19960801 056

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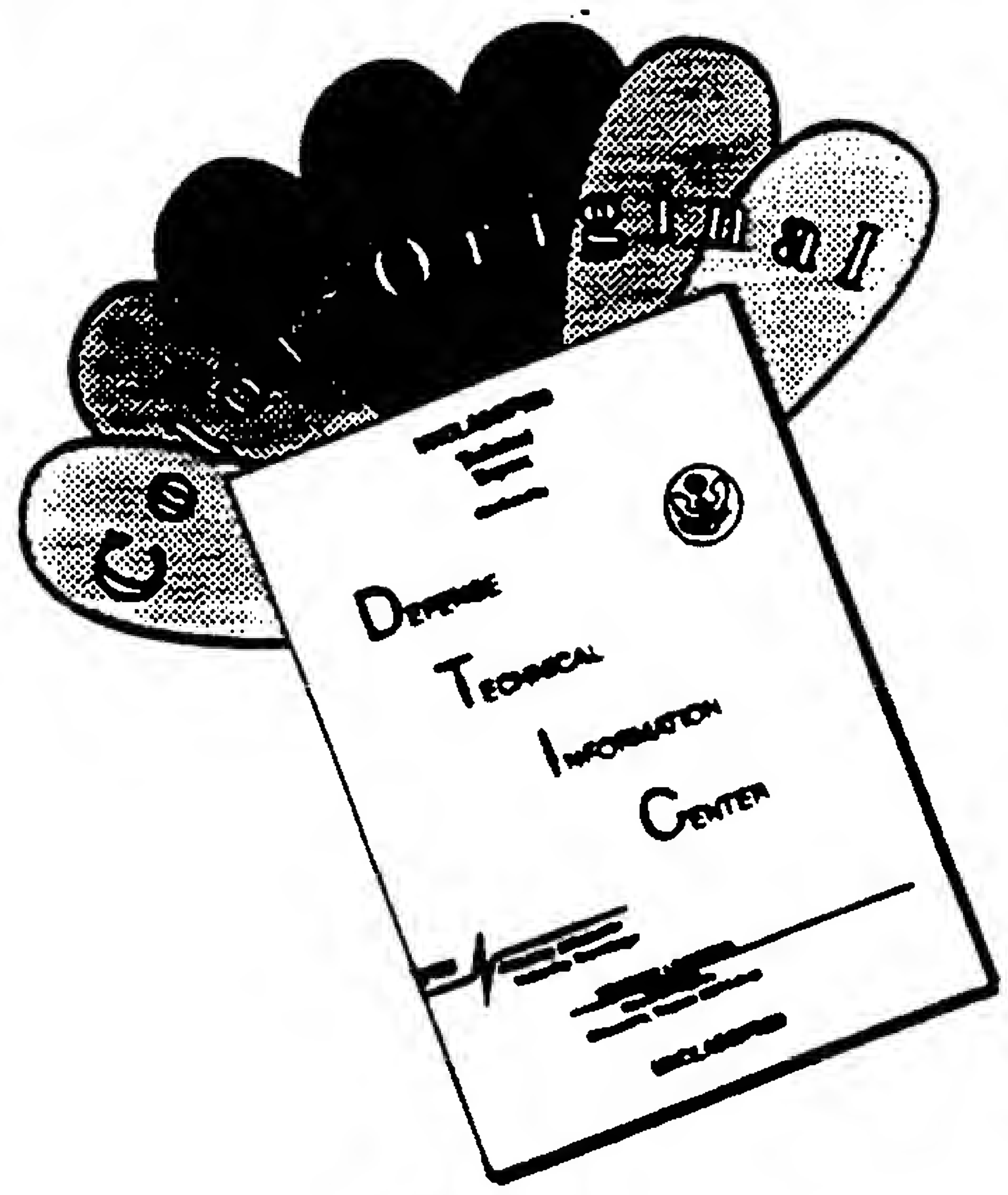

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REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	1 June 1996	64th MORSS Final Program and Book of Abstracts, 18-20 June 1996

4. TITLE AND SUBTITLE

64th MORS Symposium—*Leveraging Technology for the Military Analyst*

5. FUNDING NUMBERS

O & MN

6. AUTHOR(S)

Natalie S. Addison, Publisher
Cynthia Kee-LaFreniere, Editor

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

Military Operations Research Society, Inc.
101 S. Whiting Street, #202
Alexandria, VA 22304-3418

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

Chief of Naval Operations, N81
Washington, DC 20350-2000

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT

Approved for Public Release; Distribution Unlimited

12b. DISTRIBUTION CODE

13. ABSTRACT ***(Maximum 200 words)***

This publication contain titles of presentations made at the 64th MORS Symposium (64th MORSS), along with names, addresses, phone and fax numbers and e-mail addresses of authors, if available. In addition, abstracts of presentations, which are Unclassified and Approved for Public Release, are included. Some abstracts are missing because they were not cleared for public release at the time of publication.

14. SUBJECT TERMS

15. NUMBER OF PAGES

i-viii, 1-210, C1 - C16

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	UNLIMITED

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Sta. 239-18
298-102

SECURITY CLASSIFICATION OF THIS PAGE

CLASSIFIED BY:
DECLASSIFIED ON:

SECURITY CLASSIFICATION OF THIS PAGE

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TABLE OF CONTENTS

Working Groups (WG)

INDEX

CENTERFOLD

MAPS

PLENARY SESSION
TUESDAY - 0830 - 1000 - 18 JUNE

Keynote Session and General Membership Meeting ...... Eisenhower Auditorium

- Call to Order and Announcements
  Richard E. Helmuth, Program Chair, 64th MORSS
- Host Welcome
  LTG **Leonard D. Holder, Jr.**, Commander, Combined Arms Center and Fort Leavenworth
- Society Welcome
  Christine A. Fossett, MORS President
- Sponsor's Welcome
  Walter W. Hollis, FS, Deputy Under Secretary of the Army (Operations Research)
- Keynote Address
  David M. Maddox, General, USA, Retired
- Seventh Annual Membership Meeting of the Military Operations Research Society
  Christine A. Fossett, President
  - 1996 State-of-the-Society Address
  - Presentations
    - Barchi Prize
    - Rist Prize
    - Fellows Credentials
    - Wanner Award

SPECIAL SESSION I
TUESDAY - 1330 - 1500 - 18 JUNE

Special Sessions Coordinator
Dr. Stuart H. Starr, The MITRE Corporation

Tuesday, 1330 - 1500 .... **Bell Hall, Marshall Auditorium**

Leveraging Technology for the Military Analyst: Framing the Analysis

- Coordinator: Dr. **Russell Richards**, The MITRE Corporation: *Quick-and-Dirty Modeling*
- Dr. **Paul Evans**, The MITRE Corporation: *The Use of Electronic Meeting Systems (EMS) and Decision Analytic Software to Frame Complex Decision Problems*
- Mr. **Alan Zimm**, Johns Hopkins University/APL: *The Warfare Analysis Laboratory Exercise Process*
- Dr. **Henry Neimeier**, The MITRE Corporation: *Framing the Problem for Analysis of Precision Strike Attack Against Mobile Targets*

The efficient analysis of complex decision problems requires that operations research analysts pay careful attention early in the study cycle to properly framing the analysis to determine the desired product, to determine the important issues to be examined, to construct alternatives, to understand the objectives, and to scope the effort. A variety of new COTS software products has allowed analysts to leverage technology to assist in framing the problem.

This session will explore the use of some of the promising software tools which have been used recently to great advantage in getting a handle on approaching complex military decision problems. It will look at the role of groupware and decision analytic software and the use of some modeling environments for "quick-and-dirty" analyses. It will also look at the use of wargaming to help frame the problem.

Tuesday, 1330 - 1500 . . . . **GIF, Dupuy Auditorium**

A Workshop Report: Developing a Framework for Joint Mobility Analysis

Coordinator: **James L. Johnson**, Deputy Director, PA&E (Theater Assessments and Planning)

Mobility analysts have applied the tools of operations research to the study of transportation requirements and capabilities of the DoD for over 20 years. The objectives of analysis are much the same today, but both computing environments and contingency planning have changed dramatically over time. In September, 1995, this MORS Workshop devoted two days to the examination of Strategic Mobility. Its purpose was to develop a framework for analysis of mobility issues. This presentation will summarize the results of the workshop and be accompanied by a presentation from United States Transportation Command on the Transportation Analysis Modeling and Simulation Functional Process Improvement Process Study.

Tuesday, 1330 - 1500 . . . . **Bell Hall, CR-2**

Meet the Editors

Dr. **Gregory S. Parnell**, Virginia Commonwealth University; Editor, *Military Operations Research*
Dr. **Julian I. Palmore**, University of Illinois; Editor, *PHALANX*

This Special Session is your chance to discuss the scope and direction of your publications with the senior decision makers. Anyone with a general interest in these publications, or individuals interested in publishing in *PHALANX* or *MOR* cannot afford to miss this session. We look forward to seeing you there.

Julian Palmore intends to discuss several practical items of interest to *PHALANX* contributors. These include (1) deadlines to be observed, (2) guidelines for submissions, (3) the *PHALANX* audience, (4) importance of the lead article, (5) *PHALANX* departments, and (6) the role of the printer in last minute sizing decisions about how to structure an issue.

Greg Parnell will discuss several journal topics of interest to Military Operations Research contributors. These include: editorial policy, guidelines for submission, the MOR audience, the paper review process, and statistics on acceptance rates.

Tuesday, 1330 - 1500 . . . . **Bell Hall, CR-6**

Prize Paper Session

Prize Committee Chair

LTC **James E. Armstrong,** USMA

Barchi Committee Chair:

Dr. **William E. Skeith,** Logicon RDA

Rist Prize Committee Chair:

James B. Duff, PRC, Inc.

RIST PRIZE PAPER: ***Exploring a Relationship Between Tactical Intelligence and Battle Results***

MAJ **E. Todd Sherrill**, TRAC Analyst, Operations Research Center, USMA
Dr. **Donald R. Barr**, Department of Systems Engineering, USMA
West Point, NY 10996
914-938-5661; Barr 914-938-4696

We investigated the effects of combat results of varying levels of information a combat commander has about his adversary. We performed experiments in which individual subjects, playing the role of combat commanders, provided detailed plans for conducting offensive operations against an enemy defender. The combat commanders prepared five plans in sequence, all in the same attack scenario, but with increasing levels of information about the enemy's intent and disposition. We implemented and executed each of the commanders' attack plans in the Janus combat simulation model. Ten independent battles were fought with each plan. The combat effectiveness of each plan was evaluated in terms of several measures of effectiveness, and information level was measured using entropy. Plots of measures of effectiveness against information level generally reveal rapid gains in effectiveness early on, with diminishing returns as the commander gains near perfect intelligence information. We believe this observed relationship may have broader, more generic, validity than just the scenario used here.

Tuesday, 1330 - 1500 . . . . **Bell Hall, CR-6**

BARCHI PRIZE PAPER: ***Choosing Force Structures: Modeling Interactions Among Wartime Requirements, Peacetime Basing Options, and Manpower and Personnel***

S. Craig Moore, Deena R. Benjamin, James S. Kakalik and **R. E. Stanton**
RAND
POB 2138
Santa Monica, CA 90407
Benjamin: 310-393-0411 ext 7138

The US military must design force structures today in the face of substantial uncertainties about future military contingencies: Where will military needs arise? What operational and support units will be needed? Options for organizing, equipping, and training units during peacetime include using concepts of tiered readiness, larger versus smaller units, or active-versus reserve-component units -- which have different operating costs and use different manpower configurations. The people who staff such units and centralized support organizations include military and civilian personnel in numerous specialties and grades.

This paper describes and illustrates an optimization framework that identifies a mix of units of different types, plus a mix of personnel that is practical and that can fill objectives during peacetime and contingencies, in a timely manner. Covering the whole Air Force, the optimization will permit planners to quickly evaluate the implications of such diverse options as (1) deploying forces on altered schedules (2) stationing fewer forces overseas in peacetime (3) staffing units in peacetime or during contingencies at different levels, (4) changing training regimens to lower some units' operating costs, (5) altering personnel behavior through incentives, or (6) opening to civilians more jobs that traditionally have been reserved for military personnel.

SPECIAL SESSION 2
WEDNESDAY - 1030 - 1200 - 19 JUNE

Wednesday, 1030 - 1200 . . . . **Bell Hall, Marshall Auditorium**

Leveraging Technology for the Military Analyst: Dealing with Data
Iris Kameny, RAND

Presenters:
Dr. **Anil Joglekar**, IDA, *New Opportunities for Military Data Collection from Field Measurements*
Dr. **Len Seligman**, MITRE, *Data Mining: An Overview*
Dr. **Walt Stanley**, BDM Federal Inc., *Data Verification, Validation and Certification for Modeling and Simulation*

In order for users of models and simulations to produce credible results they must have inputs of quality data that is timely and appropriate for their purpose. A user must: (1) be able to easily identify Authoritative Data Sources (ADS) or data voids that require new data collection efforts, (2) have rapid access to ADS data that is understandable because it has

been defined through data modeling and standardization, (3) be able to quickly determine the quality and lineage of potential datasets, and (4) be able to acquire the appropriate data sets through well defined Date Interchange Formats (DIFs) used by heterogeneous providers of data.

Data may be available directly from source collectors or from intermediate suppliers who add value to it. It may be maintained in small databases or files, large "centralized" warehouses and in distributed heterogeneous databases.

As an update, DMSO is actively supporting efforts in: ADS, data modeling and standards for complex data, data quality, development of DIFs in priority areas, and data security.

This session will begin with Anil Joglekar discussing new field implementation systems for collecting time, space, position information (TSPI) data. Len Seligman will then address data mining -- deriving information from large data collections. Walt Stanley will talk about the DMSO effort in developing guidelines for data verification, validation and certification (VV&C).

Wednesday, 1030 - 1200 . . . . **GIF, Dupuy Auditorium**

A Workshop Report: Advanced Distributed Simulation for Analysis

General Chair: **Edward C. Brady**, FS, Strategic Perspectives, Inc.
Technical Co-Chairs: **Theodore Bean**, The MITRE Corporation
Tana Reagan, Mitretek Systems

This briefing provides an overview of the unclassified workshop held in Williamsburg, Virginia on 30 January through 1 February 1996. The workshop focus was on the appropriate use of Advanced Distributed Simulation for Analysis, inherent limitations and advantages of ADS-based capabilities, current shortcomings of ADS capabilities that if remedied could significantly improve their capability, suggested ways to analyze and test the reference and quality of ADS-based tools. The keynote address was by Dr. Anita K. Jones, Director, Defense Research and Engineering.

There were six Working Groups -- Battlefield Effectiveness; Material, Systems, and Acquisitions; Test and Evaluation; Training, Mission Rehearsal, and Alternate Courses of Action, Analysis and Requirements; and Understanding Behavior and Performance. This briefing addresses why ADS is important to the analytic community and summarizes the results of the Workshop.

Wednesday, 1030 - 1200

Junior/Senior Analyst Session

Coordinators: **Eugene P. Visco,** FS, ODUSA(OR)
Robert D. Orlov, The Joint Staff

Dr. **Ricki Sweet Allison** and COL **Gabriel Rouquie, Jr.** . . . . **GIF, 352-A**

Dr. **Alfred G. Brandstein** and Mr. **Frederick L. Frostic** . . . . **GIF, 352-B**

Dr. **Sydell P. Gold** and **Edward A. Smyth** . . . . **GIF, 353-A**

Dr. **Jacqueline R. Henningsen** and RADM **Pierce J. Johnson** . . . . **GIF, 353-B**

Dr. **Roy E. Rice** and **Donna K. Vargas** . . . . **GIF, 354-A**

John A. Riente . . . . **GIF, 354-B**

SPECIAL SESSION 3
THURSDAY - 1030 - 1200 - 20 JUNE

Thursday, 1030 - 1200 . . . . **GIF, Dupuy Auditorium**

Leveraging Technology for the Military Analyst: Interfacing with Tools

Coordinator: **Nahum Gershon**, MITRE

Panelists:
- **Quintin Congdon**, NGIC, *"Integrating Tools in the Analytic Environments (Pathfinder Project)"*
- **Nahum Gershon**, (Session Coordinator) MITRE, *"Information Visualization Technology"*
- **Inderjeet Mani**, MITRE, *"Interfacing with Tools Using Natural Language Processing"*
- **Russ R. Rose**, ORD, *"The Role of Information Visualization in the Intelligence Analyst's Work (tentative)"*
- **Robert Smillie**, NRaD, *"Discovery of Battlespace Metaphors"*

The panel will present and discuss how new technologies could have impact on the military analyst's work. These technologies are potentially expected to have a major impact on all aspect of the analysis processes. Key technologies include information visualization and natural language processing (NLP).

Information visualization brings into play advances in computing and visual displays. It transforms information into a visual form allowing the analyst to observe the information. Visual interfaces allow the user to get the information faster and to discover new and old relationships in an intuitive manner. To achieve these goals we not only need to develop more tools and interfaces but also help users to develop previously de-emphasized visual skills.

ORD in cooperation with AIPASG and other members of the Intelligence community has embarked on the P1000 initiative. P1000 objectives are to improve the efficiency and the effectiveness of intelligence information processing and analysis through research, development, and application of visualization sciences and technologies within the analytical environment. The scope of the P1000 Program is to address the coordination, development, deployment, and support for information visualization technologies and sciences.

The Pathfinder Program is concerned with integrating a large number of tools and making them interoperable in the analyst's environment. It was found out that a suite of tools is more effective than the sum of the individual components. The Pathfinder Program integrated over 30 visual and non-visual tools through a common interface. For example, integrating visual tools with phrase frequency analysis can give the analyst more insight than using the tools separately. The Pathfinder Program has been implemented in real life day-to-day analyst's environments.

Natural language processing (NLP) allows an end-user to interact in a more natural fashion with tools, for example, in issuing spoken English directives to simulation systems. NLP also can have a critical role to play in facilitating decision-making in crisis situations, for example, in tools which alert users when messages relevant to a particular user's sphere of interest arrive (e.g., terrorist incidents in a particular area). New and emerging capabilities are in the area of multimedia digital libraries, for example, making it feasible to search or summarize the content of closed-captioned TV news broadcasts.

The Battlespace Metaphor is part of a larger project which has as its goal to (a) recognize uncertainty in decision making, (b) tailor the content, form, and features of available information to convey understanding to all levels of users, and (c) provide straightforward access through advanced interfaces to heterogeneous systems and applications. The intent is to define a battlespace metaphor specifically tailored for tactical data fusion and visualization by developing a process which integrates tactical data and represents the certainty and uncertainty in tactical situations in ways that enhance understanding and support individual initiative and compress decision cycles.

Thursday, 1030 - 1200 . . . . **Bell Hall, CR-2**

Education Session

Coordinator: CDR **Dennis Baer**, Naval Center for Cost Analyses

This year's Education Session is a review of the past and a chance to change the future. We will summarize the Education Colloquium held during the spring at the National Defense University. This colloquium covered topics such as undergraduate and graduate OR education, professional development of government and industry, and OR continuing education.

We will use this Colloquium as a springboard to discuss future direction that MORS should take in the Education and Professional Development area. MORS is looking forward to hearing your thoughts on important issues like Continuing Education, OR certification program, and other Educational topics that may be relevant. This is a great opportunity to represent your company, military organization, or educational institution. Our goal is to coordinate the needs of military and civilian government, industry, the educational institutions, and march forward in one direction.

Analysis for Support of Readiness & Training

The Honorable **Louis C. Finch**, Deputy Under Secretary of Defense (Readiness), Office of the Secretary of Defense
4000 Defense, 3E777
Washington, DC 20301-4000
Phone: 703-693-4067; FAX: 703-697-4128

Readiness: Keeping the Forces Ready to Fight—Readiness is the Department of Defense's top priority, and DoD leaders pay special attention to make sure their decisions maintain the readiness of U.S. armed forces -- today, tomorrow, and through the long term. But what is readiness, and what are the key factors that keep U.S. armed forces ready to fight?

In general terms, readiness is the overall ability of forces to arrive where they're needed, on time, and prepared to effectively carry out assigned mission objectives for which they were designed. The ability of units to be ready on time to carry out their missions, in turn, is a function of having the equipment, supplies, logistics, and experienced people with the skills to accomplish assigned tasks.

This overarching concept of readiness is easily understood. Yet upon closer examination, one finds that readiness is comprised of diverse elements of organization, resources, people, and leadership. It includes the ability to train, maintain, and sustain these elements in an aggregated and synergistic force that is prepared to meet mission goals. Furthermore, these elements must be balanced throughout the defense program to ensure that the department has highly capable forces which are prepared to meet those goals.

This discussion focuses primarily on readiness issues and trends as they relate to the near-term readiness of U.S. military forces. It recognizes however, that DoD programs must strike a balance between readiness considerations in the near, mid, and long terms. Indeed, maintaining readiness in the near and mid term will help bolster the force in the long term. Long-term capability depends, among other things, on the modernization of weapons and equipment. In the past, having technologically superior equipment has been a key to the success of American forces in combat. Maintaining that advantage will continue to be paramount to U.S. success in future battles.

Current Readiness Assessment Tools—Several initiatives for better current readiness assessment tools will be discussed. Among these initiatives include: Senior Readiness Oversight Council (SROC), Joint Monthly Readiness Review (JMRR), Joint Automated Readiness System (JARS), SORTS Improvements, Joint Mission Essential Task Lists (JMETLs) as readiness standards, and the Readiness Indicators Baseline Project.

As military forces shrink in size and the missions they perform are becoming more diverse, the Department must place a premium on forces being able to conduct joint operations. Today's and tomorrow's forces will fight jointly; this requires a new level of cooperation. In addition to the traditional readiness requirement of keeping individual units able to fully perform their individual functions, now these units must be integrated, across Service lines, into an effective joint force. A chief initiative is the CINCs' specifying their missions as JMETLs, complete with conditions under which the tasks must be performed and the standards to be met by their units or staffs. This project does not change the missions that the CINCs are expected to perform. Rather it specifies the tasks in sufficient level of detail to allow staffs and units to train and fully develop the necessary level of both unit and joint readiness. This ongoing process focuses on train-like-you-fight activities and will serve to revolutionize joint training and exercises. It will eventually provide a basis to measure readiness in terms of output (ready to accomplish the specified mission) rather than today's input-oriented (ready to perform as intended by the unit design) processes.

Simulation for Training—The readiness of U.S. forces is directly related to the quality of their training. While the phrase "train-as-you-fight" has become a well worn cliché in some circles, the ability to provide realistic joint training across all phases of military operations for all types of missions remains a formidable challenge. While the Services have made great strides in developing simulation technology that supports individual and unit training, substantially more progress is needed in providing a capability to support interservice and joint task force training. Recognizing this urgent need, the Office of the Secretary of Defense (OSD), the Joint Staff, and the Services are coordinating their efforts to create a coherent integrated plan for the use of modeling and simulation in support of joint and interservice training.

The Deputy Under Secretary of Defense for Readiness and the Joint Staff Director for Operational Plans and Interoperability, in collaboration with the Director, Defense Research and Engineering and the Military Services, have established a Training Council for Modeling and Simulation. The primary objective of this council is to develop and implement joint and interoperability training simulation plans that represent the needs and interests of the training community.

A major focus of the new Training Council is the Joint Simulation System (JSIMS) program. The JSIMS program represents a quantum leap over existing training technology. It will encompass the full range of missions across all phases of military operations. It will share a common architecture with other training simulations as well as analytical and acquisition related models. Finally, it will interface with actual command, control, communications, computers, and intelligence (C4I) equipment in the field. DoD has established a Joint Program Office for management of the JSIMS program and is in the process of providing staffing from

each of the Services. A new program element has been established for the core JSIMS developments, and efforts are underway to coordinate related Service activities to develop their respective functional areas (mission spaces) of combat for JSIMS.

The Department has given priority to exploiting enhanced modeling and simulation through distributive technology. The Department's policy for joint readiness includes proactive application of simulation technologies in the areas of joint training, exercises, and readiness monitoring. The DoD Modeling and Simulation Master Plan will be amended with a definitive description of the requirements, plans, and programs to support joint and interoperability training. In addition, DoD is pursuing development of better modeling methods to improve U.S. capability to predict the interaction of forces and reduce the fog and friction of war. The net result of this coordinated effort by the Services, Joint Staff, and OSD will be increased efficiency and interoperability, as well as improved cost effectiveness, through more efficient utilization of the simulation technology.

Better Resources-to-Readiness Tools—The Services are currently assessing their models for relating resource inputs to readiness outputs. Although these models are useful, they are somewhat limited in scope. The Department is currently developing macro-level readiness resource methods. A strategy has been developed for applying these measures to the Operation & Maintenance (O&M) budget and for conducting a piece-wise, historical analysis for application as a future resources-to-readiness predictor. One of the Department's primary concerns in the resources area is the need for better Contingency Funding mechanisms. New concepts are being explored to conduct and fund peacetime operations without creating a serious negative impact to unit readiness.

Conclusion—DoD continuously faces new challenges to readiness as the world changes. Based on past experiences, America's vigorous responses to each, and the valuable lessons derived, U.S. forces today are ready to fight -- ready to get where they are needed, on time, to carry out the nation's tasks.

For FY 1997 and beyond, the Department will maintain the readiness of its forces to carry out the National Security Strategy. The policies and programs enumerated in this discussion demonstrate the continued attention and high levels of initiative and energy with which the Department is addressing these challenges and will set the stage for ensuring readiness for the future. Such efforts rest with the shared responsibility between Congress and the Department. With approval of these proposals, particularly timely funding for contingency operations, the United States will continue in the future to have the world's best trained, best equipped force run by the world's best men and women. The role of Military Analysts and MORS is very important in providing both the improved tools and processes as well as the in-depth analyses to keep our forces ready.

Thursday, 1030 - 1200 . . . . **Bell Hall, CR-6**

A Workshop Report: Information Warfare (IW) and Deterrence

RADM **James Cossey,** USN (Ret.), SAIC
Dr. **Richard E. Hayes**, Evidenced Based Research, Inc.
Cossey: 703-749-8657; FAX 703-790-1409
Hayes: 703-893-6800 ext 26; FAX 703-821-7742

A workshop on Information Warfare and Deterrence was held at the National Defense University (NDU) on February 13 and 14 to examine two related issues: First, the requirements and ways to deter IW attacks on the US and its interests, and second, how IW might be used to deter conventional and non-conventional threats against the US.

The first part of this presentation is Admiral Cossey's summary of a US Navy sponsored war game conducted at the Center for Naval Analyses. This summary was used to anchor and focus the NDU workshop and provided an excellent centerpiece for discussion. The presentation, entitled "Strategic Deterrence-Information Warfare War Game," describes a seminar war game ghat uses a Middle East scenario to explore the impact of IW as seen from different perspectives including the US National Command Authority (NCA), the Unified Command commander in chief (CINC), the "world" view, and so on. The findings not only covered IW actions in isolation, but also how these actions might combine, or need to be combined with other measures.

Next, Dr. Hayes will present the findings of the SECRET level IW and Deterrence work shop, its findings, and the other areas identified as necessary for further analysis. Conclusions deal with technical, operational and policy issues.

Special Session 4
Thursday - 1530 - 1700 - 20 June

Thursday, 1530- 1700 . . . . **GIF, Dupuy Auditorium**

Leveraging Technology for the Military Analyst: Conducting the Analysis

Coordinator: **Marchelle Stahl**, Institute for Defense Analyses

Presenters:

- **Steven Bankes**, RAND - *Credible Reasoning with Weak Models*
- **William Schoening**, McDonnell Douglas Aerospace - *Overview of J-MASS: An Environment for Building Models and Performing Analysis*
- **Peter Spellman**, MITRE - *Demonstration of the Collaborative Virtual Workstation*

Analysts are moving into a new era, where use of advanced distributed simulations (ADS) will be commonplace, and in some instances mandated. ADS refers to simulations that can interoperate with other simulations at geographically separate sites. These simulations can be live, virtual or constructive and will be capable of interoperating with simulations of a dissimilar category (e.g., live with virtual, or constructive with virtual).

ADS holds both promise and pain. On the one hand, certain areas of analysis that have been difficult to model, e.g., areas dependent on human behavior, like command and control, may yield to ADS. Another benefit of ADS, particularly in the acquisition area, will come from the opportunity for analysts to collaborate with other analysts at different geographic sites and with other specialists, e.g., engineers, and test and evaluation personnel. On the other hand, creating a reasonable combination of models, with suitable input data, that produce valid results, will become much more difficult.

The presentations in this session will touch on various aspects of this new analytic environment. Steve Bankes will discuss credible analysis using weak models. Bill Schoening will describe J-MASS, a new kind of modeling and simulation tool, and its analytic potential. Peter Spellman will demonstrate the Collaborative Virtual Workstation, designed to support collaboration by intelligence analysts at disparate physical locations, and discuss its applicability to more general military analysis.

Thursday, 1530 - 1700 . . . . **Bell Hall, Marshall Auditorium**

A Task Force Report: Advanced Battlespace Information System (ABIS) Task Force

Presenter: Dr. **David T. Signori**, Jr, Special Assistant for Warfare Information Technology, Deputy Director for C2, Information Systems Office, DARPA; and Executive Secretary, ABIS Task Force

The Revolution in Military Affairs and the Information Technology Revolution are motivating radically new concepts for warfighting and for the role of information technology in support of the warfighters. Both the Joint Staff and the Director of Defense Research and Engineering (DDR&E) recognize the need to strengthen the coupling between the operational and technology communities in DOD so that approaches toward a joint vision of the future battlespace can be coordinated and mutually supportive.

Vice Admiral Arthur Cebrowski, Joint Staff J-6, and Dr. Anita Jones, DDR&E, established an Advanced Battlespace Information System (ABIS) Task Force in September 1995 and charged it with developing an initial concept and plan to achieve the operational vision for the year 2010 and beyond. The Task Force included participants from operational and technical organizations across DOD. Dr. David T. Signori, Jr, ARPA, led the effort on behalf of VADM Cebrowski and Dr. Jones. The Task Force focused on operational concepts and information technologies needed to establish a global information grid and provide support for future battle management and sensor-to-shooter processes.

Dr. Signori and other members of the ABIS Task Force will discuss the vision of the future battlespace, with particular emphasis on changing operational concepts and the enabling technologies. They will also present the Task Force's views on processes and initiatives necessary to implement the new capabilities.

TUTORIALS

TUESDAY, WEDNESDAY, THURSDAY - 1215 - 1315

Tutorial Coordinator:
Dr. Roy E. Rice, Teledyne Brown Engineering

Tuesday, 1215 - 1315 . . . . **Bell Hall, Marshall Auditorium**

■ *Modeling for Campaign Analysis: Lessons for the Next Generation of Models*

Richard Hillestad, Louis Moore, Bart Bennett, RAND

It is a widely held belief that the national security environment and military technology has changed so dramatically that the models for defense analysis must change fundamentally and considerable effort and money are now being expended to develop new models.

In this tutorial we will first argue that the problem is not only with the models but also a lack of recognition of what constitutes good model based analysis. The focus is on campaign level modeling (rather than engineering, engagement, or missions models) because, at this level, one considers the most important determinants of a theater war's outcome and military force structure. The topics discussed include: 1) Approaches to analysis with a campaign model; 2) Data issues in campaign analysis; 3) Achieving transparency in the application of a campaign model; and 4) A defense community program to improve future campaign analysis.

Finally, we will discuss how these analysis issues should influence the design of the next generation of campaign models.

Tuesday, 1215 - 1315 . . . . **Bell Hall, CR-6**

■ *Using Values to Generate Alternatives*

Dr. **Gregory S. Parnell**, Virginia Commonwealth University, Department of Mathematical Sciences

Most operations researchers believe that their most fundamental objective is to help decision makers make better decisions. The standard OR approach focuses on defining the problem, building a model, evaluating alternatives, performing sensitivity analysis, and presenting the results to decision makers. Somehow the alternatives are *magically* identified during this process. Decision makers and stakeholders usually provide their favorite alternatives. Experienced analysts sometimes create alternatives that span the decision space and use analysis techniques to gain insights about potential alternatives. However, many analysts do not focus on generating alternatives.

There are several reasons that analysts do not emphasize creating alternatives. Some may believe alternative generation is not important. Most analysts have not been educated and trained in alternative generation. Also, there are no accepted techniques or algorithms for alternative generation. Finally, some analysts may believe that, if they are perceived as alternative advocates, they could lose their objectivity.

These obstacles can and should be overcome. Alternative generation is critical: if we want better decisions, we need to find better alternatives. This tutorial provides techniques that analysts can use to generate alternatives. These techniques use the decision makers' values to generate alternatives that create value. Finally, if they are perceived as facilitators and not advocates, analysts can help generate alternatives and still maintain their objectivity.

Tuesday, 1215 - 1315 . . . . **Bell Hall, CR-2**

■ *Determining the Force Structure Trade Space, Specifically Addressing Intelligence, Surveillance, and Reconnaissance (ISR) and Dominant Battlespace Awareness (DBA)*

Roy Rice, Teledyne Brown Engineering

The purpose of this presentation is to motivate the analysis community (MORS specifically) to "get out of the box" and begin to think of new ways of modeling combat and addressing force structure issues; particularly force structure trade-offs. It begins by redefining the Force Structure Trade Space from traditional terms like lethality into new terms like

Battlespace Awareness (BA). It asks the question, "If you could quantify DBA, what would you do with it?" The presentation contains definitions of ISR, BA, and DBA and suggests a method to quantify them. It also proposes an algorithm by which to model combat in terms of BA. Many questions are posed and not all of them are answered....the challenge is for the MORS community to start answering them.

Wednesday, 1215 - 1315 . . . . **Marshall Auditorium**

■ *Value-Focused Thinking*

Lt Col **Jack A. Jackson**, Maj **Lee Lehmkuhl**, AFIT/ENS and Maj **Jeffrey S. Stonebraker**, USAFA/DFMS

This tutorial will describe how one applies value-focused thinking. Value-focused thinking involves clearly defining what's important to the decision maker (i.e., objectives), creating effective measurement scales of the lowest-level objectives, assessing the relative importance among the lowest-level objectives, and constructing a value model.

Value-focused thinking embodies the principles of multi objective decision analysis or multi-attribute utility theory; but approaches decisions as opportunities rather than waiting for a decision to become a problem. This tutorial will highlight applications of value-focused thinking in the AF 2025 study; Defense Base Closure and Realignment Process; and the next Officer Career Management System (i.e., a replacement for DOPMA).

Wednesday, 1215 - 1315 . . . . **Bell Hall, CR-6**

■ *Modeling Joint Mobility Problems: A Tutorial*

Dr. **Yupo Chan**, AFIT/ENS and **James L. Johnson**, OSD/PA&E

There has been a perceived chasm between the applications community and the research community involving the ways and means to resolve air-mobility and transportation problems in general. While there is a need for high-quality analysis to be performed on a day-to-day basis, the state-of-the-art technologies are often not brought to bear upon the problem. At the same time, the research community is equally frustrated about the lack of sophistication in analysis performed on a real-time basis, which prevents important insights to be gained. It has been said that many of the technological advances of operations research are at least twenty years ahead of applications. In response to this problem, this tutorial is geared toward narrowing the gap between research and applications by having a meaningful, structured dialogue between the two sides.

Recent efforts strive to integrate mobility issues into existing campaign analysis. This will bring mobility to the theater level, in which real-time, stochastic events are explicitly modeled. Also of importance is multi modal transportation systems, wherein lift capacity is provided by a combination of aircraft, trucks, rail, as well as water-borne vessels. This is in response to the "new world order," wherein the strategic confrontation between the East and the West is now replaced by regional conflicts which can flare up at a moment's notice. Strategic-mobility requirements are now over shadowed by tactical transportation demands. Furthermore, increasing emphasis is placed on joint operations.

Wednesday, 1215 - 1315 . . . . **Bell Hall, CR-2**

■ *Operational Effectiveness Analyses for Systems That Don't Shoot*

Charles R. Hall III, MITRE

Operational Effectiveness can be fairly easily assessed for systems directly involved with ordnance; either launching outbound or intercepting inbound ordnance. Identifying and defining MOEs is usually fairly straight-forward even if calculating those MOEs is difficult. One identifies the objectives of the Operational Commander about two levels above the system under consideration and articulates those objectives in terms of traditional measures such as "bombs on target" or "own force survivability." Then the study effort can focus on how to calculate those MOEs and what the results mean. The difficulty comes when one is asked to assess the operational effectiveness of a system not directly involved with ordnance. Training and C4 systems are prime examples of such recalcitrants. The first principle to recall is that the purpose of most operational effectiveness analyses is to provide insight to an executive so that he can make a solid decision on some issue. If at all possible, that insight should be offered in operational terms. That means finding a way to link the capabilities of the system under consideration to the objectives of the appropriate Operational Commander. This presentation suggests concepts for approaches to developing such linkages. These concepts grew out of the efforts that developed analytical methods which were then employed in the effectiveness assessments for two recent COEAs. Those methods will be presented as examples of operational effectiveness analyses for systems that don't shoot.

Thursday, 1215 - 1315 . . . . **Marshall Auditorium**

■ *Lanchester on Lanchester Intelligence*

Michael W. Garrambone, Veda, Inc.

One of the best attended sessions and highly praised tutorials being presented again this year is about a British automotive and aeronautical engineer who published the results of his investigations on the military applications of aviation at a time when flying had only just been proven possible. This individual's theories stand today as the cornerstones of "equations of combat," and are considered to be amongst the most valuable analytical contributions to the art of war. To those who have been terrorized by his academic references or have relied on his equations (the algorithms which drive the attrition processes in our many-on-many combat simulation models) a description of Lanchester's actual thoughts have never really been presented. Despite the numerous references and devilish derivations based on his famous equations, we have lost out on the mind set and content of Lanchester's basic work. To remedy this shortfall in information, to answer the question. "What exactly did Lanchester say?, this paper examines in an interesting and enlightening tone the recorded thoughts of one of the most important contributors to leveraging technology and information in the form of modern analysis. The paper discusses the then (1917) envisioned strategic and tactical uses of air power, weapon effectiveness analysis, and technological issues in reconnaissance, joint and combined arms operations. It discusses Lanchester's concepts on aviation command, control, and logistics; the national and political implications associated with air power development; and one man's vision of the importance of battle space dominance through technology.

Thursday, 1215 - 1315 . . . . **Bell Hall, CR-6**

■ *MASTR (Modeling, Analysis, Simulation and Training), A New Look*

Steve Boyd, AFSAA/SAGD

This presentation will describe the result of the Object Oriented Analysis (OOA) for redesign of the MASTR application.

The review and analysis was deemed critical as the first MASTR design/architecture showed itself as inappropriate to support the ongoing analyst requirements. Analysts began to require more sophisticated tools, especially for setting up and running models within the MASTR environment. This analysis represents the high level design specification for the new version of MASTR and was created from the MASTR Project Analysis Working Notes. The "MASTR Project Redesign-Design Documents" builds on this specification and OOA. It describes Object Oriented Design (OOD), which is a low-level and potential implementation level design.

The presentation loosely follows the Coad-Yourdan OOA/OOD. design method, modified where appropriate to deal with the unique requirements of MASTR. Where object diagrams are used, they use Coad-Yourdan OOA notation.

Thursday, 1215 - 1315 . . . . **Bell Hall, CR-2**

■ *Using DTIC to Publish MORS Papers*

Frank Scott, Defense Technical Information Center (DTIC)

Find out how submitting your documents to DTIC benefits not only your organization but also the entire DoD community. Learn about various electronic vehicles available to search and retrieve bibliographic information of technical reports stored at DTIC. See outline demonstrations of internet access to DTIC data bases via the Scientific Technical Information Network (STINET).

POSTER SESSION
FRONTIER CONFERENCE CENTER
TUESDAY - MIXER - 1715 - 1900 - 18 JUNE

Poster Session Coordinator:
Sue Iwanski, Northrop Grumman Corporation

The Poster Paper Session for the 64th MORS Symposium provides an outstanding opportunity for presentations to a wide audience. This session will be held at the Mixer Tuesday, 18 June, 1715 - 1900. The following is a list of poster presentations that will be displayed at the Mixer.

ATPS: The Automated Test Planning System

David Duma
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Richard Ledesman and **Stuart Layman**
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The Automated Test Planning System (ATPS) is an expert systems based analysis tool to aid the acquisition community in the test planning mission. In recognition of the sheer volume of information that must be considered in developing or reviewing a test plan, test evaluation plan, TEMP, or any other T&E related documentation, any tool that can assist test planners to do their jobs faster, more efficiently, or more comprehensively is of great benefit. ATPS is a "system of systems," unique modules that focus on different aspects of the test planning mission. These modules have a common user interface that seamlessly presents work processing tools, an extensive hypertext help environment, and expert systems tools.

The three ATPS modules are as follows:

- **The TEMP Review Module (TRM)** is designed to aid Action Officers in the review and approval of Test and Evaluation Master Plans (TEMPs). TEMP Review features an Intelligent Check list of key issues to consider in reviewing a TEMP.
- **The T&E Program Risk Assessment Module (TEPRAM)** aids Service component staff in managing key risk factors by providing for harmonization of key acquisition documents, such as the ORD, Analysis of Alternatives, TEMP and risk management plan, and providing a baseline of issues to consider in assessing program risk.
- **The TEMP Build Module (TBM)** provides the Service T&E staffs with tools to help build key elements of the Test and Evaluation Master Plan. TEMP Build presents an expert systems based checklist that contains both Service specific and OSD guidance which the analyst uses to write a draft TEMP. The output of the TEMP Build module is a "rough cut" TMEP in the 50002-M format. Simple graphics tools to help the analyst create an integrated schedule and matrix components of the TEMP are also available.

ATPS is an analysis tool, designed to aid the human analyst, not to replace technical thoughts. It provides a standard baseline for TEMP development, risk assessment, and evaluation within a comprehensive, yet easy-to-use, interactive environment. As DTSE&E moves forward, streamlining the acquisition process by implementing tools such as ATPS will help to improve productivity and meet cost-cutting measures without sacrificing high-quality work.

The JTCG/MF&AS Crew Casualty Project

J. Terrence Klopcic and **David Neades**
US Army Research Laboratory
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The task of the Crew Casualty Project is to develop a comprehensive, DoD-accreditable personnel vulnerability assessment methodology that is consistent across all military tasks and all conventional threats - a standard person for all JTCG analyses.

The process of operational casualty assessment was divided logically into three parts: the determination of the injury resulting from an insult, the determination of the impairment of the ability to perform elemental functions, and the determination of the effect of such impairment upon the performance of military jobs. (Also issuing from the determination of the injury is a medical assessment and the determination of medical casualties.) This taxonomy of the process allowed the existing expertise in many pertinent specialty areas to be efficiently combined into the development of one consistent, comprehensive methodology. For example, the early steps in the personnel vulnerability evaluation process involve data common to the medical community; the later stages involve analyses similar to those done in the fields of industrial engineering and ergonomics. Such specialized expertise has been used in every portion of the Crew Casualty Project.

The Crew Casualty Methodology has now been implemented in the Operational Requirement-based Casualty Assessment (ORCA) Computer Code. ORCA is implemented on both workstations and PCs with an extensive menu-driven interface to assist the user in exercising the methodology with options for outputs at several degrees of granularity.

In this poster session, the ORCA Code will be available for user trails.

Building a Data Warehouse for Modeling and Simulation

Frank Simuro
OD/PA&E, Information Management & Analysis Group
1225 Jefferson Davis Hwy, #300
Arlington, VA 22202; Comm (703) 604-6349; FAX (703)604-6400

The JDSS speaker will address the development and implementation of a data warehouse designed to provide information to models and simulations. The discussion will cover key components of the data warehouse architecture to include databases (source and target), data tools (analysis, query, and management), metadata schema (version control, standards, modeling tools, and data dictionary), communications (connectivity, security), and archival capability (for data inputs and study results) required to build the computing infrastructure and information reservoir to sustain the Joint Analytic Model Improvement Program (JAMIP).

Our approach supports the development of a robust warehouse containing many types of data (forces, performance, logistics, etc.) in a variety of structures and formats. The data store will involve multi-layered filters and translation mechanisms that transform elements from heterogeneous sources into easily accessible "datamarts" containing integrated, model-ready information. The datamarts are customer-specific, accommodating varying degrees of granularity--from the detailed, "primitive" level through the aggregated level--and a range of output formats (e.g., object oriented, relational or flat files). Information (data and meta-data) in the warehouse will be available for ad hoc queries through a "web-like" browser interface.

Our speaker will also touch on joint data support issues dealing with populating the warehouse, implementing data verification, validation, certification and standardization processes, and analyzing the data to develop information tailored to modelers' requirements.

When Sleds Fly--Selecting the Best Alternative for Future High Speed Testing at the Holloman High Speed Test Track

Major **Eileen Bjorkman**
846th Test Squadron, 1521 Test Track Road
Holloman AFB, NM 88310
(505)679-2133; Fax:(505) 679-2906; E-mail: ebjorkman@mailgate.46tg.af.mil

A video will be shown related to the paper with the same title scheduled in Working Group 2.

Timeline of Simulation Milestones

Dr. **Jack Thorpe**, SAIC

At the MORS ADS Workshop earlier this year we saw a timeline illustrating the history of simulations. The latest version of this timeline will be available for review and comments.

Personal Computers and Military Application/ACVAT Example

Dr. **Urban H.D. Lynch**
UHL Research Associated, Inc.
7926 Berner St.
Long Beach, CA 90808
310 493-19 55

A demo will be given related to the paper with the same title scheduled in Working Group 31.

Multiprocessor ECM Verification Instrumentation

Andrew M. Henshaw and **Richard V. Morrison**
Georgia Tech Research Institute
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This paper describes a multiprocessor system for the real-time measurement and verification of the electronic countermeasures (ECM) emanating from a jammer-equipped aircraft. This Jammer Mode Verification Instrumentation (JMVI) is capable of simultaneously sampling, transforming, and analyzing multiple ECM techniques against multiple threats. The JMVI is composed of a fast-turning microwave receiver with multiband outputs; a high-speed digital data acquisition system; a parallel-processing computer network for control, analysis, and verification of ECM technique parameters; and a PC-based user interface.

The JMVI measures and verifies the parameters associated with noise, amplitude modulation, frequency modulation, Doppler modulation, and range-based deception techniques. A few of the parameters measured and verified include *pulse width, pulse-repetition interval, relative power*, and *technique period.* In its automatic mode, the system provides a pass/fail status that allows an operator to simultaneously monitor multiple threat/ECM techniques responses. In manual mode, detailed data is provided to allow isolation of ECM technique anomalies and failures.

Prairie Warrior Advanced Warfighting Experiment

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This presentation highlights the evolution of Prairie Warrior, The Command and General Staff College end-of-year student exercise at Ft Leavenworth, KS, in terms of its role in supporting Force XXI experimentation. The context of each exercise and associated experiments from 1993 through 1996 are provided, along with intellectual and procedural insights for past years and a layout of the 1996 experiments.

General Campaign Analysis Model (GCAM)

Mr. **Evan Farris** and Dr. **William Lyle**
Systems Planning and Analysis, Inc.
2000 N. Beauregard St., Suite 400
Alexandria VA 22311
Phone: (703) 931-3500; FAX: (703) 931-9254

See GCAM abstract under “Demonstrations.”

Mobile Integrated Non-Intrusive Command, Control, and Communications Instrumentation (MINI-C3I)

Maj **Lawrence L. Turner, Jr., John W. Diem** and **Sherry A. Hannan**
TEXCOM
Attn: CSTE-TCC-D, Bldg 91014
Fort Hood, TX 76544
817-286-6325

Force XXI implements the concepts of power projection and information warfare to mobilize, employ, and sustain highly trained combat forces anywhere in the world. This will involve upgrading weapon and communication systems to use the capabilities of emerging digital technology. This digitization of the battlefield will significantly change the command and control architecture of the new digitized force. The resultant command and control infrastructure will need to be tested to ensure it provides the commanders the right information at the right time. MINI-C3I is being developed to enable this new architecture to be tested and evaluated. MINI-C3I will provide the capability of collecting internal external data from mobile or static units composed of varying numbers of combat, combat support, and combat service support units. Data collection instrumentation and statistical analysis software will be developed to a level that will support evaluation of the implementation of battlefield digitization initiative from the weapons platform to Corps level. These data can then be used to evaluate the horizontal (interoperability) and vertical command and control functionality. To conduct cost effective testing, the system will be integrated with the Family of Simulations (FAMSIM)(e.g., Corps Battle Simulation (CBS) with attendant interfaces, JANUS, Brigade and Battalion Simulation (BBS), Extended Air Defense Simulator (EADSIM), etc.) To provide the required levels of detail and battlefield information flow to properly stimulate player units, commanders, and staffs during operational tests and experiments.

DEMONSTRATIONS—DAILY DURING SYMPOSIUM
TUESDAY, WEDNESDAY, THURSDAY

Tuesday, 1000 - 1700, — *Wednesday, 0830 - 1645,* — *Thursday, 0830 - 1500* . . . . **GIF, 253-C**

J-MASS Demo

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J-MASS (Joint Modeling and Simulation System) is being demonstrated on a continuous basis during the regular hours of the symposium. Tools for building, configuring, executing, and post processing results from simulations are being demonstrated for the most recent release of J-MASS. Copies of user manuals are available for your inspection. Information about how to establish a J-MASS user site is also available.

J-MASS provides operations analysts with a single simulation environment for building, executing and post processing models and simulations on UNIX workstations. Models and simulations built in J-MASS can be either real-time or event-based, can include both hardware-in-the-loop and operator-in-the-loop, and operate in a distributed processing mode over a heterogeneous set of computers.

Tuesday, 1000 - 1700, — *Wednesday, 0830 - 1645,* — *Thursday, 0830 - 1500* . . . . **GIF, 253-D**

General Campaign Analysis Model (GCAM)

Mr. **Evan Farris** and Dr. **William Lyle**
Systems Planning and Analysis, Inc.
2000 N. Beauregard St., Suite 400
Alexandria VA 22311
Phone: (703) 931-3500; FAX: (703) 931-9254

The General Campaign Analysis Model (GCAM) is a set of modeling tools developed to support the N81 and JMA assessment processes. GCAM has been designed to provide a flexible, high-level, object-oriented modeling environment for applications from the joint campaign level down to the unit engagement level. Application development for N81 has focused on the use of GCAM as a tool for integration of modeling supporting the POM assessment process. This tasking has included creation of GCAM interfaces to other modeling tools and development of a combined LRC/MRC joint campaign scenario

GCAM is designed to be used by operations research analysts to develop object-oriented modeling applications. A GCAM model includes a user-defined set of objects that interact in an environment that includes map-based movement, sensors, command and reporting architectures, logistics and inventory control, conditional unit orders, and tracking of damage and attrition. The environment can be used to develop stand-alone applications, to integrate data and results from other models, or to combine these two processes.

The presentation will include an overview of the GCAM development effort, a technical summary describing the major components of GCAM, and a model demonstration showing the combined LRC/MRC campaign case.

Other Special Events

Tuesday, Wednesday and Thursday, 1330 - 1500 .... **Bus Pick-up at Bell Hall Loop, 1330**

Battle Command Battle Laboratory (BCBL)

The mission of the Battle Command Battle Laboratory (BCBL) is to focus the use of new technologies on the problems of Command and Control. The Lab contains the equipment and prototypes of the Control centers of the Army of the next century. The prototypes represent command Tactical Operations Centers (TOCs), and are equipped with the latest digital equipment giving the commander both a view of the battlefield and allowing him and his staff to project the status of friendly and enemy forces as a result of the battle plans.

Visitors to BCBL will be shown the Division TOC and the air mobile TOC to be used by the Corps, Division and Brigade commanders in the next century. These prototype Centers are equipped with the prototype communications gear and digital flat panel displays that will provide the commander with an overview of the battlefield. A fusion center that merges the intelligence inputs from a multitude of sources into a single intelligence graphic for the commander is also represented. The structure has been used recently by Command and General Staff College (CGSC) students participating in the Prairie Warrior Exercise, enabling future Army commanders to experience the command and control centers of the future Army.

The bus will **DEPART** from the **Loop in FRONT of Bell Hall** at 1330 daily to transport you to the tour.

Wednesday, 1330 - 1500 .... **GIF, 253-A**

New Working Group Planned for the 65th MORSS: *Analytic Support to Training*

Coordinator: **Brian R. McEnany**, SAIC

MORS will support the activation of a new Working Group during the 65th MORSS at Quantico, Virginia. In preparation for that event, there will be a short organization meeting of interested analysts in the GIF, Room 253A on Wednesday, 19 June, 1330-1500. The purpose will be to discuss objectives and charter for the group. The proposed chairperson is Brian McEnany with Col Tom Verbeck, JWFC as co-chair. The working group will focus on analytic support of training, exercise and operational training, and training effectiveness issues. The agenda is expected to include ADS applications devoted to analysis of training, use of constructive, live and virtual M&S in support of training, and operational support.

Wednesday, 1515 - 1645 .... **GIF, 253-A**

Advanced Distributed Simulation Senior Advisory Group (ADS SAG)

Chair: Dr. **Henry Dubin**, USA OPTEC

The SAG will meet to discuss the following agenda: Charter, Vision and Near Term Activities.

General Information
64th MORSS Final Program

MORS Office

MORS will have an office at Fort Leavenworth during the 64th MORSS. It will be located in **Bell Hall, Classroom 8,** ground floor. The office will be open on Thursday, 13 June, 0830-1700, Friday, 14 June, 0830-1130, and Monday, 17 June, 0830-1700; on 18, 19, 20 June, 0700-1730. The phone numbers for the MORS office at Fort Leavenworth are **913-684-7750**, FAX **913-684-7788**. They will be **activated on 13 June**.

Attendee Support Office: Phones, PC's and Printers

Classroom 9, ground floor, Bell Hall, will be provided as an office to support you during your stay at MORS. Up to 12 telephones will be provided for your use, plus ten personal computers (PC's) and 2-3 printers. Eight PC's will be networked for access to e-mail (telnet). The other two will be available for word processing, last minute slide changes, etc. They will be loaded with the Microsoft Suite (Powerpoint, WORD, ACCESS, and EXCEL) plus Word Perfect 6.0.

Government Quarters

MORS has been advised by the Fort Leavenworth Lodging Operations office that government quarters and messing ARE NOT AVAILABLE. Further, they have advised us that to accommodate this constraint, orders should specify ***Kansas City, Missouri*** as the TDY destination, with the following disclaimer provided in Block 16 of DD Form 1610: *"Use of Government facilities would adversely affect the performance of the assigned mission."*

Statements of Non-availability

Statements of non-availability WILL NOT be provided.

Lost and Found

The Lost and Found will be in the MORS office, Bell Hall, Classroom 8, during the Symposium. Lost and Found items not claimed at the end of the Symposium will be left with the host facility.

Mixer

There will be an informal mixer at the Frontier Crossroads Club, on Tuesday evening, 18 June, from 1715-1900. There will be a cash bar. Transportation will be provided back to the hotels before and after the mixer.

Western Barbecue

On Wednesday evening from 1830 - 2130, MORS will hold a Western Barbecue. The National Agricultural Center and Hall of Fame at Bonner Springs, Kansas, will be the site of the Barbecue for the 64th MORS Symposium. The Barbecue will include beef, pork and chicken and all the trimmings. Your ticket to this event will include admission to the Hall of Fame Museum, hay rides and train rides around the Agricultural Center grounds. Live music will round out the evening's entertainment.

The cost is $20.00 per person. Tickets MUST be purchased in advance and the cost is non-refundable. Transportation will be provided to the hotels before and after the Barbecue.

Lunches and Snacks

The following facilities are available within walking distance.

- General Instruction Facility (GIF) Cafeteria, Room 153 **(Open 0630 - 1400)**
- Bell Hall Cafeteria (located in basement) **(Open 0630 - 1400)**
- Trails West Golf Course Snack Bar
- Burger King
- PX Snack Bar
- Bowing Alley Snack Bar
- Transportation will be provided to and from the Frontier Conference Center
- Many restaurants are located outside the main gate.
- Box lunches will be available for those attending tutorials on Tuesday, Wednesday and Thursday. The cost is $6.00 each. Box lunches for Tuesday were ordered on your application form. Wednesday and Thursday box lunch tickets will be sold on Tuesday and Wednesday in the MORS office, Classroom 8, Bell Hall, ground level.

Coffee

Coffee and snacks will be provided without additional charge. Coffee will be served on Tuesday, Wednesday and Thursday at the following times:

0700-0830 1000-1030 1500-1530

Designated Smoking Areas

Smoking is NOT permitted in any building at Fort Leavenworth. The designated smoking areas are located outside each building.

Bus Transportation from Hotels to Fort Leavenworth and Back

All buses will drop-off and pick-up in the Loop (Horseshoe Drive) in front of Bell Hall

DAY	Depart Hotels	Arrive FLVN (Bell Hall)	Depart (Bell Hall)	Arrive Hotels	Arrive FCC (Mixer)	Depart (Mixer) to Hotels
TUESDAY (4 buses)	0545 0700 0730	0635 0750 0820	1715 1715	1800 N/A	N/A 1720	N/A 1900
	1100 - 1400 Two buses will run a lunch shuttle between Bell Hall and FCC					
WEDNESDAY (5 buses)	Depart Hotels	Arrive FLVN Bell Hall	Depart Bell Hall to Hotels	Arrive Hotels	Depart for BBQ from Hotels	Depart BBQ to Hotels
	0545 0700 0730	0635* 0750** 0820	1700	1745	1800	2030 2100 2130
	1100 - 1400 Two buses will run a lunch shuttle between Bell Hall and FCC					
THURSDAY (4 buses)	Depart Hotels	Arrive FLVN Bell Hall	Depart Bell Hall	Arrive Airport/Hotels		
	0545 0700 0730	0635 0750 0820	1215, 1355, 1415, 1535, 1555, 1715, 1735	50 minutes later		
	1100 - 1400 Two buses will run a lunch shuttle between Bell Hall and FCC					

FLVN = Fort Leavenworth FCC = Frontier Conference Center (formerly FLVN Officers Club)

* Stops en route at FCC to drop off Working Group/Composite Group Chairs for Town Hall Meeting

** After Bell Hall drop-off, buses go to FCC to retrieve WG/CG Chairs at Town Hall Meeting, take them to Bell Hall.

NOTE: Two FLVN buses shuttle between Bell Hall and FCC each day for lunch, 1100 - 1400

Attendees are reminded of the necessity for continuing attention to security precautions. While every effort will be made to provide a secure facility for the meeting and to insure that attendees are properly identified, cleared, and in possession of the required need-to-know, all are reminded that the responsibility for the unauthorized disclosure, particularly with regard to conversations, rests with the individual attendee. Attendees are requested to keep in mind the following important points:

1. Be careful WHERE you make classified disclosures. Do not extend classified discussion to hotels, restaurants, officers' clubs, or other places in which you are unable to positively identify all within hearing distance and be reassured of the nonexistence of eavesdropping devices.

2. Be careful TO WHOM you make classified disclosures. You should assure yourself that the people to whom you are talking are indeed registrants at the 64th MORSS. You are advised that a uniformed or civilian person located away from the restricted area of the meeting and not personally recognized as a registrant does not have authorized access to classified information, regardless of his possession of a MORS name badge.

3. The attention of non-government attendees is invited to the NISPOM, Chapter 5, Section 5, with regard to disclosure authorizations.

4. Attendees are advised that possession of photographic, audio recording or electronic transmitting devices is not authorized in the meeting spaces of the 64th MORSS.

Admission Policy

Admission to the secure area of the meeting is limited to holders of current printed invitations properly authenticated and issued by the MORS office to the named individual for his attendance at the 64th MORSS.

Persons who enter or attempt to enter the secure area of the meeting without proper invitation and persons who aid, encourage, or willfully permit improperly authorized persons to enter the secure area of the meeting are liable for citation for security violation.

Invitations

The only admissible invitation is the official 64th MORSS Invitation issued by the MORS Office. Other invitations, including official invitations for earlier MORSS, are invalid. There is no provision for one-session-only invitations and MORS has no obligation to issue invitations after the announced deadline or to work out invitations for persons who arrive uninvited at the meeting. ***Invitations must be brought to the meeting. They are required for registration.***

Restricted Meeting Areas

Those portions of the meeting area lying inside of the posted guards are designated restricted meeting areas for the 64th MORSS. All classified presentations and discussions in connection with the MORSS program are to be conducted inside this area. Only the following persons are permitted access to MORS meeting areas:

- Officially invited 64th MORSS attendees with appropriate MORS-issued name badges and approved ID cards;
- MORS staff and service personnel with appropriate MORS-issued name badges and approved ID cards;
- Members of the 64th MORSS guard force;
- Officials representing the host command on official business.

Entry to the Meeting Areas

Entry to the restricted meeting areas will be regulated by the guard force and working group chairs and cochairs.

At each entry to the meeting area, each attendee will be required to stop long enough to show his properly validated 64th MORSS name badge and his identification and to be recognized by the guards. The name badge and ID card should be displayed at all times within the restricted meeting area. The guards or working group chairs and cochairs will check the following before admitting an attendee to the classified area:

- The validity of the ID card
- The validity of the name badge
- The correspondence of face and ID picture
- The correspondence of name on badge and ID card.

So that the ID check can be accomplished quickly, name badges and ID cards must be displayed together in the MORS name badge holder.

PLEASE NOTE: Cameras and tape recorders are not allowed in the classified areas at the Symposium.

Picture ID Cards

All attendees in the restricted meeting areas are required to display their ID cards in the MORS badge

holders along with their name badges. Only two types of ID cards are permissible: the active duty military ID card and the ID card issued by MORS. The MORS-issued ID cards will be delivered to the attendees when they register. It is important that the attendee return the card to the MORS office when leaving the meeting. Otherwise, the attendee will have to obtain a new ID card for subsequent MORSS.

MORS Name Badges

A MORS name badge is issued to each properly registered attendee, along with a plastic pouch for its display. Attendees should take care that the badge is not lost or loaned during the meeting as these are avenues for improper entry and security violations. Badges should not be changed, corrected, or altered in any way. If such action is necessary, a member of the MORS staff will issue and authenticate a new badge at the MORS Office, Classroom 8, Bell Hall.

Note Taking

Classified presentations will be delivered orally and/or visually. Classified documents will not be distributed and classified note-taking and electronic recordings are not permitted by attendees during classified presentations.

Classified Matter --Transmittal

Classified matter transmitted by mail may be picked up in the MORS office upon presentation of MORS credentials, after 1000 on Tuesday, 18 June 1996.

When no longer needed for the Symposium, attendees may bring their classified material to the MORS office to be wrapped for hand carry or transmittal to their parent activity. ***The attendee is responsible for providing a letter of transmittal to be included in the package.*** The meeting security staff will be responsible for proper wrapping and marking of inner and outer envelopes in accordance with Navy security regulations. The address for classified mail shown on the attendee's personal security voucher will be used for mailing purposes. MORS will accept responsibility for mailing a properly wrapped and sealed package by registered mail and will provide the attendee with a receipt for the sealed package. Because of congestion, MORS staff will not be able to wrap packages during the breaks between sessions.

Classified Matter—Overnight Storage

The MORS office will accept (until 15 minutes after the end of the last session) and safeguard (for the meeting duration) classified matter to the level of SECRET. Material will be accepted as a package rather than loose. Receipts must be presented on recovery of material by its holder. The MORS office staff is cleared to the SECRET level.

Classified Matter — Late Arrival

In the event that you arrive at Fort Leavenworth during non-duty hours and need to store classified material, present the material to the Staff Duty Officer at the front entrance to Bell Hall. Bell Hall is found by entering the front gate of Fort Leavenworth, proceeding north along grant Avenue for 1.4 miles, and turning right on Reynolds Avenue (3rd traffic light). Bell Hall is the last building on the right (about 3 blocks). Proceed up the horseshoe drive and enter the left entrance. Your material will be secured overnight, and instructions for its retrieval will be provided to you at that time.

Classified Disclosure

Persons participating in the discussions at the 64th MORSS have been granted limited disclosure authorization via their personal security vouchers for the 64th MORSS. It is the individual responsibility of each participant to find out in advance, from his certifying official, the limits to his own classified disclosures and to stay within those limits at the symposium.

A written disclosure authorization is required for all papers and presentations (government and contractor). All disclosure authorizations must be forwarded to the MORS Security Manager. If the disclosure authorization is not received by MORS prior to the symposium, the presentation will be canceled.

David Rist and Barchi Prize Awards

MORS offers two prizes for best papers—the ***Barchi Prize*** and the ***Rist Prize***. The ***Rist Prize*** is awarded to the best paper in military operations research submitted in response to an announcement and call for papers. The ***Barchi Prize*** will be awarded to the best paper from the entire symposium, including Working Groups, Composite Groups, and General and Special Sessions.

David Rist Prize: Papers submitted in response to the announcement and call for papers were eligible for consideration for the *Rist Prize*. The committee selected the prize-winning paper from those submitted and will award the prize at the 64th MORSS. The author(s) will present the paper at the 64th MORSS and may prepare it for publication in the MORS Journal, *Military Operations Research*. The cash prize is $1000.

Richard H. Barchi Prize: Author(s) of those papers selected as the best paper from their respective Working Group or Composite Group, and those of the Special Sessions at the 63rd MORSS were invited to submit the paper for consideration for the Barchi Prize. The author(s) will present the paper at the 64th MORSS and may prepare it for publication in the MORS Journal, *Military Operations Research*. The committee selected the prize-winning paper from among those presented and submitted. The prize will be presented at the 64th MORSS. The cash prize is $1000.

MORS Purposes and Objectives

The purpose of the Military Operations Research Society is to enhance the quality and effectiveness of classified and unclassified military operations research. To accomplish this purpose, the Society provides media for professional exchange and peer criticism among students, theoreticians, practitioners, and users of military operations research. These media consist primarily of the traditional annual MORS symposia (classified), their published proceedings, special mini-symposia, workshops, colloquia and special purpose monographs. The forum provided by these media is directed to display the state of the art, to encourage consistent professional quality, to stimulate communication and interaction between practitioners and users, and to foster the interest and development of students of operations research. In performing its function, the Military Operations Research Society does not make or advocate official policy nor does it attempt to influence the formulation of policy. Matters discussed or statements made during the course of its symposia or printed in its publications represent the positions of the individual participants and authors and not of the Society.

The Military Operations Research Society is operated by a Board of Directors consisting of 30 members, 28 of whom are elected by vote of the Board to serve a term of four years. The persons nominated for this election are normally individuals who have attained recognition and prominence in the field of military operations research and who have demonstrated an active interest in its programs and activities. The remaining two members of the Board of Directors are the Past President who serves by right and the Executive Vice President who serves as a consequence of his position. A limited number of Advisory Directors are appointed from time to time, for a 1-year term, to perform some particular function. In addition to the members, the Society maintains a general distribution list of its clientele to whom announcements, newsletters, and information are routinely sent.

The MORS Board of Directors wants to make the meetings and other operations of the Society as responsive as possible, both to the needs of the times and the desires of the members. Consequently, attendees are invited to communicate their relevant ideas and thoughts to any Officer or other Director or to the Society in writing. Where practicable, your communications will be duplicated and furnished to the MORS Board Members and Program Chairs for guidance in respect to future plans and operations.

The following are particularly encouraged:

- Offers of help in future symposium programs and working groups.
- Proposals for establishing new working groups.
- Suggestions for future banquet speakers, keynote speakers, meeting themes, meeting sites, arrangement improvements.
- Criticism of current operations or programs.

The Society will consider all comments, suggestions, and proposals.

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COMPOSITE GROUP I — STRATEGIC
Working Groups 1, 3, & 4
Chair: Pat McKenna, USSTRATCOM/J533

Tuesday, 1530 - 1700 . . . . GIF, Dupuy Auditorium

Deterrence and Warfighting in an NBC Environment

Jerome H. Kahan
Center for Naval Analyses
4401 Ford Avenue
Alexandria, VA 22303
703-824-2977; FAX 703-824-2631

This paper investigates questions that US military planners must address in preparing to deal with regional NBC threats. To provide a conceptual foundation, two fundamental elements of deterrence and their interrelationship are discussed: threat of retaliation and denial of success. To reinforce deterrence and provide hedges if deterrence fails, a series of synergistic countermeasures against regional NBC attacks against US forces are then analyzed; counter force strikes; active defenses, and passive defenses.

The paper also discusses the role of training and doctrine in countering NBC threats on the battlefield. Finally, a four-part strategy is outlined for enhancing the ability of US forces to deal with regional NBC threats.

Mr. Kahan is Director of Regional Issues at the Center for Naval Analyses (CNA). The opinions expressed in this paper are those of the author, and do not necessarily represent those of CNA, the Department of the Navy, or the Department of Defense, National Defense University Press plan to publish this paper as a chapter in a forthcoming book.

COMPOSITE GROUP II — NAVAL WARFARE
Working Groups 5 & 6
Chair: William M. Mulholland, McDonnell Douglas Aerospace

Tuesday, 1030 - 1200 . . . . GIF, Dupuy Auditorium

Analyzing Data: Developing Concise Answers for the Senior Military Officer

RADM Thomas B. Fargo, USN
OPNAV N81
Panel Discussion: Invited N81, N80, OSD(PA&E), MCCDC, JHU/APL, HQMC

In today's world of declining resources, it does not matter if it is detailed analysis or "spreadsheet" analysis, the available data must be deciphered, analyzed, and then developed into a clear presentation summarizing the results for the Boss. The Senior Officer or decision maker does not have the time to review a significant amount of information; therefore, the final product must be concise. Composite Group II's Panel of analysts will discuss ideas for analyzing data and developing concise answers for the Senior Military Officer in today's fiscal environment.

COMPOSITE GROUP III — AIRLAND CONTINGENCY OPERATIONS

Working Groups 2, 7, 8, 9, 10, 11, 12, 13 & 14
Chair:James L. Wilmeth III, Seta Corporation
Cochair: John R. Statz, Booz, Allen and Hamilton, Inc.

Wednesday, 1330 - 1500 .... Bell Hall, Marshall Auditorium

Joint Warfare System (JWARS)

Dr. **Jim Metzger**
Office of the Director, Program Analysis and Evaluatin
JWARS Office
1800 Defense Pentagon
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metzgerj@paesmtp.pae.osd.mil

JWARS will be a state-of-the-art simulation of joint warfare for use in analysis. The Deputy Secretary of Defense initiated the JWARS development in 1995 as one component of the overall Joint Analytic Model Improvement Program (JAMIP). This presentation discusses the types of analyses to be supported by JWARS, the key funtionality to be included in the simulation, and the approach to development.

Panel:

James L. Johnson,OSD, PA&E
Dr. **Jim Metzger**, JWARS Office
Vince Roske, Joint Staff/J8
Fred Frostic, DASD(Requirements & Plans)
BGen **Thomas Case**, USAF/XOM
COL **Paul Hanover**, Marine Corps Modeling & Simulation Office
John Riente, ODCSOPS
Matthew Henry, N81D
Dick Mosier, OASD

COMPOSITE GROUP IV — SPACE/C3I

Working Groups 15, 16, 17 & 18
Chair:Audree Newman, AFSAA/SASS

Thursday, 1330 - 1500 .... GIF, Dupuy Auditorium

Battlespace Awareness and the ISR Planner within the JFACC's Integrated Planning and Execution Architecture: A Future Look

Capt **Richard L. Oarr**, USAF
HQ USAF/XOOC Checkmate
1520 Air Force Pentagon
Washington DC 20330-1520
703-693-1035; FAX 703-693-1020

Huge leaps in technology have transformed the way many functional areas do business in the military today. Intelligence, surveillance, and reconnaissance, logistics communications, operations have each capitalized on recent advancements in computing to create systems that support their respective functional areas. In the process, they have created

massive, stove-piped data-stream generators. However, decision makers and planners, as the receptors of the functional array of data-streams have not experienced a similar business transformation: they remain hostage to the limits of their mind's ability to cross-correlate data and weigh cost-benefit analysis, usually in real-time. The evolution of knowledge-based systems, the ability to view into the future using modeling and simulation (M&S), the rapidly increasing computer processing capability and communications band-width and the continuing requirement to increase productivity using fewer manpower resources all support this transformation. By creating a cross-functional, data-integration tool using these enablers and coupled with a strategies-to-task construct (as embodied in the Joint Forces Air Component Commander (JFACC) Planning Tool (JPT), we can reasonably create (1) a coherent and distributed battle space awareness, (2) a seamless planning to execution environment, (3) coherent change detection with recognition of militarily significant "events," and (4) the full realization of sensor-to-shooter opportunities.

COMPOSITE GROUP V — RESEARCH AND DEVELOPMENT

Working Groups 19, 20, 21, 22 & 23

Chair:John M. Green, Lockheed Martin

Thursday, 0830 - 1000 . . . . GIF, Dupuy Auditorium

Reengineering the Army Evaluation Process: Leveraging Technology, Organization, Culture

John F. Gehrig
US Army Test and Evaluation Management Agency
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Consolidation of Army test ranges and evaluation activities has been continuously studied and implemented for the past 20 years. The recent accelerated reduction in the Defense budget have resulted in further consolidations over the past few years. Consolidation has many costs to include financial, lost expertise and decreased capability. Recurring savings that are based on already downsized and consolidated organizations are generally small.

Industry has found that reengineering the business process has been a valuable tool in restructuring the organization to provide the customer with a quality product within vastly reduced budgets. As the Army test and evaluation infrastructure has consolidated and reduced in size by one third in the past four years and is on a glide slope to reduce in size by one half by 1999, it became apparent that we needed to take a serious look at how we do business into the 21st century. The Vice Chief of Staff of the Army assigned the Test and Evaluation Management Agency to be the lead for conducting a business process reengineering study with the goal of reshaping Army test and evaluation to meet future test and evaluation requirements. The business process reengineering task force had representation from the testing, analysis, laboratory, project manager, requirements and cost analysis communities.

Results of this effort reflect the need to redesign the evaluation process in an attempt to minimize testing requirements. Evaluation process alternatives have been developed and several of the observations of the task force have already been incorporated into the analysis and evaluation process.

COMPOSITE GROUP VI — RESOURCES AND READINESS
Working Groups 24, 25, 26, 27, 28 & 29
Chair:Mary JoAnn Carroll, AFSAA
Cochairs: Mary Bonnett, SAG and Dr. Patrick Allen, Cubic Applications

Wednesday, 1515 - 1645 .... GIF, Dupuy Auditorium

Infrastructure Vulnerabilities—Implications for National Security and Assurance

Brenton C. Greene
Director for Infrastructure Policy
The Pentagon, Room 1D464
Washington DC 20301
703-614-2616; FAX 703-695-1978

The infrastructures of the United States are increasingly linked together into a complex system of networks, driven by tremendous technological advances such as the explosion in telecommunications connectivity and our reliance on information services. Critical infrastructures include telecommunications, power distribution, oil and gas pipelines, finance and securities, water distribution, emergency and health services, among others. The new technologies linking these networks introduce their own vulnerabilities, potentially allowing terrorists or other actors to undermine critical infrastructure elements of the government, our society and economy. There are significant implications for the nation, the Defense Department, the intelligence and law enforcement communities, and corporate America. Solutions are complex, beginning with the necessity to raise awareness to issues, but also to pursue assurance and protection options, with clear implications for operational research, information security, and other vital underlying issues. This briefing will address these issues from a DoD and national perspective.

COMPOSITE GROUP VII — METHODOLOGIES AND TECHNOLOGIES
Working Groups 30, 31, 32 & 33
Chair:LTC Mike McGinnis, Naval War College

Wednesday, 0830 - 1000 .... Bell Hall, Marshall Auditorium

PANEL: Determinants of Future Force Readiness Indicators

Chair: LTC **Mike McGinnis**, Naval War College
LTC **David W. Hutchison**, USMA, Operations Research Center
Michael S. Lancaster, Strategic Assessment Center, SAIC
Capt **Jeff Lancaster**, Dept of National Security Decision Making, Naval War College
MAJ (P) **George Stone**, Combined Arms Command

This panel will discuss the area of future force readiness indicators for operational and training environments. This includes the need for new indicators of military readiness that reflect changes to force structure, new types of military operations other than war, and the increasing integration of computer and information technologies throughout the armed forces.

WG 1 — STRATEGIC OPERATIONS — Agenda

Chair: Dr. Gene J. Schroeder, Los Alamos National Laboratory/TSA-3
Cochair: Robert V. Gates, Naval Surface Warfare Center - Dahlgren Division/K407
Cochair: Capt. Jeffery D. Weir, United States Strategic Command/J533
Room: GIF, 178

Tuesday, 1030-1200
Analysis of Strategic Force Postures
Mary-Margret K. Little, Systems Planning and Analysis, Inc.

Application of Genetic Algorithms to Targeting Problems
William A. Bearden, Roberta Carlisle, and James W. McNulty, ANSER

Tuesday, 1530-1700
COMPOSITE GROUP I SESSION .... GIF, Dupuy Auditorium

Wednesday, 0830-1000
Nuclear Weapons Blast Effects Planning
MAJ Nicholas J. Wager (USA), USSTRATCOM/J531

Combining Weapon Radii and Damage Sigmas from Independent Weapon Effects
John St. Ledger, Los Alamos National Laboratory

Wednesday, 1330-1500
An Alternative Weapon Allocation Methodology
Maj Mark A. Gallagher, (USAF), Capt Jeffery D. Weir (USAF), USSTRATCOM/J533

Combined Nuclear/Non-Nuclear Force Effectiveness Analysis
Dr. Gene J. Schroeder, Los Alamos National Laboratory

Wednesday, 1515-1645
Strategic Force Structure Under START II Uncertainty
LCDR Richard K. Hartman II, Patrick J. McKenna, USSTRATCOM/J533

Contribution of MARK 5 Re-entry Body to Effectiveness of SLBM Force Against a Postulated START II Target Base
Samuel G. Hughes, Robert V. Gates, Naval Surface Warfare Center Dahlgren Division

Thursday, 0830-1000
System Analysis of Attacks Against Mobile Targets
Dr. Elisabeth A. Youmans, Dr. Anthony Kooharian, Systems Planning and Analysis, Inc.

Network Interdiction Planning Tool
LCDR Philip S. Whiteman, Maj Mark A. Gallagher (USAF), Capt Jeffery D. Weir (USAF), USSTRATCOM/J533

WG 1 — STRATEGIC OPERATIONS — Abstracts

Tuesday, 1030-1200
Analysis of Strategic Force Postures

Mary-Margret K. Little
Systems Planning and Analysis, Inc.
2000 North Beauregard Street, Suite 400
Alexandria, Virginia 22311
Phone: (703) 578-5609; Fax: (703) 578-5690
mlittle@spa.com

The Strategic Stability Model is a mathematical model designed to evaluate the strategic balance between potential adversaries and, in turn, to assist in force structure studies. The model introduces a "cost and revenue" approach to the assessment of potential strategic (nuclear) exchanges. Unlike traditional approaches whose primary measures have been damage to the target base of the opponent (or even all adversaries), this approach employs the concept of "Strategic Profit". Profit, in turn, results from revenue (measured in terms of target damage) and cost (measured in terms of the value of the strategic assets). In this model, based on the concept of economic utility, all potential actions are profit motivated. This leads to new insights into strategic stability, force sizing, and even attack sequencing. Defensive (BMD) as well as offensive (SLBM and ICBM) forces can be evaluated in the model.

The presentation will introduce the model including the concepts of strategic revenue, cost, profit and stability; provide a bilateral example with offenses only; and then expand the example to include defenses on both sides. Multilateral versions of the model are feasible and under development but will not be presented.

Application of Genetic Algorithms to Targeting Problems

William A. Bearden, Roberta G. Carlisle and James W. McNulty
ANSER, Inc.
1215 Jefferson Davis Highway, Suite 800
Arlington, VA 22202
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Fax: (703) 416-3225

Genetic algorithms provide an efficient search technique for selecting near-optimal solutions for a wide range of real world problems. This presentation describes a genetic algorithm for selecting aim points for m weapons in a complex of n weighted targets to achieve high damage and satisfy other criteria or constraints. The algorithm generates and evaluates an initial, usually random, set of candidate solutions. The best or fittest solutions are then allowed to reproduce creating a new generation that will generally contain better solutions. The process continues for some number of generations, and the best member of the final generation accepted, at least provisionally, as the solution. The reproduction process is modeled on biological reproduction with occasional random mutations. For each member of the new generation, a pair of parents is selected from the current population, with fitter solutions given a higher probability of selection. The parents swap "genetic" information (in this case coordinates of aim points) and produce offspring that, by combining the parents' most desirable characteristics, may be better solutions. Random changes analogous to mutations reduce the possibility of selecting a locally optimal solution and missing a global one.

Illustrative computations for a problem with a known solution are presented first. Then, more complex problems are presented and their solutions are compared to solutions generated by a sequential enumerative optimization method. We also discuss the selection of crossover (reproduction) and mutation operators as well as other parameters of the genetic algorithm such as parent selection and fitness calculation.

<u>*Tuesday, 1530-1700*</u>
COMPOSITE GROUP I SESSION

GIF, Dupuy Auditorium

<u>*Wednesday, 0830-1000*</u>
Nuclear Weapons Blast Effects Planning

MAJ Nicholas J. Wager (USA)
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The strategic environment will become more competitive and uncertain in the future, making it more difficult to predict and counter strategic threats. Strategic decision makers require maximum flexibility in the Courses of Action (OAS) their staffs present for consideration. Analysts supporting the decision making process must provide the best assessment of these COAs. Current strategic analyses of nuclear COAs use the Physical Vulnerability System (PVS) to model nuclear weapons' blast effects through a set of algorithms called PDCALC. Currently the PDCALC model does not predict Probability of Damage (PD) from blast effects: for targets whose location is known in a probabilistic sense; nor for targets attacked by a weapon whose planned Height of Burst is above the Mach reflection region. USSTRATCOM analysts have developed methodologies derived from the PVS to examine and predict nuclear weapons blast effects for these two situations.

Combining Weapon Radii and Damage Sigmas from Independent Weapon Effects

John St. Ledger
Los Alamos National Laboratory
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stledger@lanl.gov

The Physical Vulnerability System is the accepted methodology for mathematically treating such diverse factors as target vulnerability, weapon accuracy, yield, and height of burst in order to calculate a probability of damage to a target from a nuclear detonation. The system uses two parameters, the weapon radius and damage sigma, to estimate the probability of damage using a complementary, cumulative, log-normal distribution. Many targets can be classified as being vulnerable to a particular weapon effect, and the presentation of the weapon radius and damage sigma data is straight forward. However, personnel targets present a different kind of problem. People can be vulnerable to overpressure, radiation, and thermal effects. The combined weapon radius can be much larger than the weapon radius for each effect considered independently, and the damage sigma is generally different for each effect. The Physical Vulnerability System has an accepted method for combining the weapon radius and damage sigma from different effects to calculate a combined weapon radius and damage sigma.

The accepted method for combining two weapon radii and damage sigmas to calculate a combined probability of damage can lead to errors in the probability of damage of 10 percent or

more. This paper briefly reviews the current methodology, presents an error analysis of this methodology, and discusses possible alternative ways of calculating the combined probability of damage from multiple, independent weapon effects.

Wednesday, 1330-1500
An Alternative Weapon Allocation Methodology

Major Mark Gallagher and Captain Jeff Weir
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With the increased speed in computers and the decreasing numbers of weapons and targets, the Arsenal Exchange Model (AEM) could be expanded to included more of the problem in the optimization. Two potential areas for optimization are the ballistic missile footprints and determination of when to combine installations into designated ground zeros (DGZs).

Currently after the optimization is complete, a heuristic algorithm is applied to ensure that the targets attacked by MIRV ballistic missiles are within a realistic footprint. This algorithm uses a simple rectangle to check footprints and swap DGZs. A different approach could be implemented in two stages. The first stage would rotate the coordinates to align with the launch azimuth and scale the dimension to the same energy required to move crossrange or downrange. This stage would enable a larger range of footprints to be consider acceptable than a rectangle in Euclidean space. The second stage would add two footprint constraints for each ballistic missile with multiple independent retry vehicles(MIRV), and thus the optimal allocation for MIRV systems would be constrained to meet the operational targeting capabilities. The first footprint constraints would select the correct number of DGZs for the weapon system. The second constraint would limit the sum of energy required to cover the footprint below the energy available for the weapon system.

The currently the DGZ construction is determined in FROBAK, prior to the optimization. The DGZ build is not restricted by the number of weapon systems available. A possible result is that two installations could be combined into a single DGZ that requires either a very capable weapon or to be double targeted. If in the AEM allocation the very capable weapon was not available, the DGZ may be attacked with two less capable weapons. A better allocation would be to attack the original installations individually. The linear program could be used to make this choice in an optimal manner.

Combined Nuclear/Non-Nuclear Force Effectiveness Analysis

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The purpose of this study is to examine the utility of augmenting the US strategic nuclear strike plan (SIOP-like) with non-nuclear weapons. The principle efforts are focused on analysis of force effectiveness and collateral effects from a strategic strike, considering different force structures. Three factors motivated this analysis effort: (1) with the end of the Cold War, the US has made significant reductions in its nuclear weapon arsenal, including strategic weapons and their associated delivery platforms. The US strategic targeting philosophy has been re-examined and the potential target list revised. The Nuclear Posture Review affirmed continuation of the current counterforce targeting philosophy. However, a concern remains as to whether the proposed nuclear stockpile is sufficient to meet objectives for a strategic strike. Non-nuclear weapon augmentations need to be investigated as potential means to address shortfalls, should they exist, (2) the Persian Gulf War brought additional emphasis on collateral effects considerations. This emphasis has also influenced strategic war planning. Non-nuclear weapons might offer an alternative for reducing collateral effects while still meeting military objectives, and (3) de-nuclearlization of the B-1 could make it available as a long-range non-nuclear delivery platform. In previous arms-limitation treaties, long-range bombers were counted as nuclear delivery platforms and the world situation made it unreasonable to displace a nuclear weapon with non-nuclear munitions. The current situation constitutes the first time that a reasonable non-nuclear delivery platform could be available for planning as part of a strategic strike.

The recently released Stimson Center study appears to have initiated a renewed interest in further nuclear arms reductions, calling for a plan to totally eliminate nuclear weapons around the world. Additionally, President Clinton has renewed the call for ratification of the START II treaty. These events, along with results of the recent Russian Duma election, seem to re-open the debate on further reduction of nuclear stockpiles.

Today's targeting philosophy, target base, and force structure are assumed as the baseline. The principal measures of effectiveness are damage expectancy and collateral effects. This is a multiple phase study: (1) Phase I - Proof-of-Principle to illustrate how the study will be conducted while data is being gathered, candidate targets are developed, and model development is completed, (2) Phase II - Baseline analysis with START I and II force structures, and (3) Phase III - Exploration of Phase II force implications with a higher fidelity model. The principal analysis tools used in all phases of this study are: (1) the Arsenal Exchange Model (AEM) with the Front End/Back End (FROBAK) model, and the Conventional Targeting Effectiveness Model (CTEM), (2) PDCALC6 for damage estimates for higher-yield standard-output nuclear weapons, (3) LANDEM for prompt casualties, and (4) LACOMP for late-time casualties. A model development effort is underway to address the estimated probability of damage for low-yield nuclear weapons.

Wednesday, 1515-1645

Strategic Force Structure Under START II Uncertainty

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In an era of uncertainty surrounding START II ratification it is imperative that a robust and capable strategic nuclear force be maintained until such time as ratification occurs. The makeup of the nation's strategic nuclear forces must be determined under a wide range of constraints. A straight forward "more is better" is no longer a viable approach. When determining force composition one must consider Target Coverage capability, Operational implications, Arms Control implications, Stability and Parity, Stockpile Support and perhaps most important, Cost. The study started with a START II compliant force structure and "robusted up" subject to START I limits using the following methodology:

- Upload the START II compliant force
- Retention of weapons systems above START II
- Increase in Triad platforms

Briefing will include a discussion of multiple force structure options to aid the decision maker in determining the most capable and cost effective option that will best meet the nation's strategic warfighting needs.

Contribution of MARK 5 Re-entry Body to Effectiveness of SLBM Force Against a Postulated START II Target Base

Samuel G. Hughes and Robert V. Gates
Naval Surface Warfare Center Dahlgren Division

An SLBM force structure analysis was performed for theNuclear Affairs and International Negotiations Branch (N514) of the OPNAV staff. The study, which considered both present and future strategic target bases, addresses the contribution made by the Mark 5 re-entry body to SLBM force effectiveness. The development of a notional START II compatible target base is described. Effectiveness comparisons are made on the basis of expected force damage computed using the Rapid Production Model (RPM). These high level results are then examined at a more detailed level by a careful examination of the target bases. The conclusions presented highlight the unique contributions of this re-entry body to SLBM effectiveness.

Thursday, 0830-1000

System Analysis of Attacks Against Mobile Targets

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The survivability of a mobile target depends on covert deployment and movement. Mobile missile transporter, erector and launchers (TELs) have distinct operating states, e.g. in motion, communicating or at rest. They have the capability of rapidly setting up, firing and disassembling, but may be vulnerable to a rapid-responsecounterattack. There are many naval targets with similar dependencies.

Our goal is to examine trade-offs involved in attacking these mobile targets. In particular, we will compare attack systems with different preparation and flight times and different associated surveillance and reconnaissance system requirements. Minimum model complexity is desirable: it must be simple enough to explore and understand the impact of parameters of the problem. Yet, it should allow for realistic surveillance/reconnaissance and command and control system characteristics.

Our approach uses a Markov multi-state model with physically realistic time behaviors. The model incorporates elements of mobile target search, targeting, attack and assessment. Mobile target detectability and the track holding time will depend on the target state. The model formulation takes into account the tactical response based on opposing and own force capabilities and their interactions.

This model will be applied to provide measures that will determine the survivability of mobile targets against several combinations of fast- and slow-reaction attack weapons, their launch platforms, and the surveillance/reconnaissance system. It is our intent to treat this problem on as high a level as possible for overall force planning.

Network Interdiction Planning Tool

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In an era of aggressive strategic force reductions it has become increasingly important to plan available weapons in the most effective manner possible. The Network Interdiction Planning Tool is being developed from currently available software to integrate mathematical techniques with the targeting expert to develop an optimal interdiction strategy for systems which have a network architecture. The tool utilizes commercial integer and linear programming software (CPLEX) to determine an optimal allocation of weapons subject to specified goals and objectives. The integer programming formulation was originally developed for interdiction of drug trafficking in South America by R. Kevin Wood at the Naval Postgraduate School. A graphical user interface has been developed using National Security Agency's OILSTOCK graphical information system. This robust interface with the operational planner in target selection analysis maintains the reasoning power of the strategist "in the loop."

WG 2 — MISSILE DEFENSE — Agenda
(Includes WG 12 — AIR DEFENSE)

Chair: Beverly Nichols, USASSDC
Co-chairs: Michael W. Ellis, BDM International
Robert Fleitz, Coleman Research Corp.
Proctor A. Grayson, Coleman Research Corp.
Frederick N. Jerding, System Planning and Analysis, Inc.
Sharon Noll, Institute for Defense Analyses
Robert K. Strider, USASSDC
Paul Tabler, System Simulation Solutions, Inc.
Advisor: Mr. Robert W. Grayson, MITRE
Room: GIF, 364

Tuesday, 1030-1200
Insights to be Gained from Force-on-Force Modeling of Theater Missile Defenses
Ms. Laura Lee, Ms. Diane G. Guthrie, SPARTA, Inc.

Integrated Theater Missile Defense Capabilities Study
Ms. Pam Roberts, US Army Concepts Analysis Agency

TBMD for an Amphibious Objective Area
Mr. John Rybicki, BDM

The Active Defense/Passive Defense/Attack Operations/BMC4I Pillar Integration (APAB-PI) Model
Mr. Karsten Engelmann, US Army Concepts Analysis Agency

Tuesday, 1530-1700
When Sleds Fly - Selecting the Best Alternative for Future High Speed Testing at the Holloman High Speed Test Track
Major Eileen Bjorkman, 846th Test Squadron

C2 Value Added Analysis for Theater Missile Defense
Mr. James Pettit, Dr. Walter Stumpf, Mr. Phillip Lyle, Systems Planning and Analysis, Inc.

Early Warning Radar System Response to Limited Ballistic Missile Attacks
Mr. Kenneth Cranford, USSPACECOM

Wednesday, 0830-1000
C4ISR and Deep Attack Weapons Mix Study (DAWMS) Modeling
Mr. Philip J. Walsh, Institute for Defense Analyses

Review of Link 16 Operational Utility Analyses
Dr. Donald J. Van Arman, Dr. Stephan R. Moore, MITRE

Value of BM/C4I to Joint Theater Ballistic Missile Defense
Dr. Charles M. Johnson, POET/MITRE; Mr. John M. Shure, POET/Aerospace

Wednesday, 1330-1500
COMPOSITE GROUP III SESSION . . . . **Bell Hall, Marshall Auditorium**

Wednesday, 1515-1645
Uncertainty and the National Ballistic Missile Defense Program
Col. David F. McNierney, BMDO-TR/R, and Ms. Pauline N. Pakidis, Coleman Research Corp.

Human Performance Measurement in Ballistic Missile Defense C2 Simulations
Dr. Beverly G. Knapp, US Army Research Laboratory

Upward Traceability: An Approach to Reducing OT&E Costs
Ms. Eloise G. Brooks, Ballistic Missile Defense Organization

Thursday, 0830-1000
TriService Attack Operations Study: Contribution of Attack Operations to the Theater Missile Defense Mission
Major Daniel L. Ball, US Army TRAC-SAC

Joint Staff TMD Attack Operations Study
LCDR Phil Pardue, Joint Staff/J8/Strike Warfare Assessment Div.

The Contribution of TMD Attack Operations at the Campaign Level
Mr. Robert Strider, USASSDC Missile Defense Battle Integration Center

TMD Pillars Balancing for WMD Threats
Dr. Anne Vopatek, BMDO/AQ , Frank Sevcik, IDA

Thursday, 1330-1500
AF BPI Study
Mr. Tom Pendergast, Simulation Support, Inc.

Air Directed Air-to-Air Missiles
Dr. Joan F. Cartier, IDA

The Cruise Missile Defense Study
Captain Jacob L. Shuford, Joint Staff (J-8)

WG 2 -- MISSILE DEFENSE -- Alternates

Aircraft Attacks on Mobile Missiles
Mr. F.S. Nyland, Nyland Enterprises

Exploring Boost Phase Intercept Concepts for Theater Missile Defense
Mr. F.S. Nyland, US Arms Control & Disarmament Agency

Deep Attack Weapons Mix Study (DAWMS) Methodology
Mr. Jim Bexfield, Institute for Defense Analyses

U-2 in Support of Special Operations
Mr. Thomas H. Plank, Sverdup Technology, Inc.

Theater Missile Defenses and Russian Retaliation Issues
Mr. F.S. Nyland, US Arms Control & Disarmament Agency

A System-Level Evaluation Methodology for Assessing the Utility of Data Fusion Systems
Mr. Judson C. Brown, Mr. James A. Paper, The Johns Hopkins University Applied Physics Laboratory

Parametric Trade-Off Analysis: Interceptor Burnout Velocity versus Radar Range
Dr. Walter Stumpf, SPA, Inc.

The Battle for Seoul
Mr. John Rybicki, BDM Federal, Inc.

WG 2 — MISSILE DEFENSE — Abstracts

Tuesday, 1030-1200
Insights to be Gained from Force-on-Force Modeling of Theater Missile Defenses

Ms. Laura Lee and Ms. Diane G. Guthrie
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Force-on-Force modeling of Theater Ballistic Missile Defense (TBMD) can aid a program acquisition decision maker. This paper provides examples of results and insights obtained through force-on-force modeling in the first phase of

the Ballistic Missile Defense Organization (BMDO) Theater Missile Defense (TMD) Capstone Cost and Operational Effectiveness Analysis (COEA). The insights presented are in the area of the utility of proposed systems, impacts of various mission requirements, benefits from BMC4I and requirements balancing within the architecture.

First, an approach to force-on-force modeling with linkages to lethality, attack operations and deployability is described. The approach is then applied to the Capstone COEA context and results are presented for the defense of North East Asia and South West Asia. The results demonstrate how force-on-force modeling, when its limitations are clearly understood, can provide useful measures of merit for program decisions.

Integrated Theater Missile Defense Capabilities Assessment (ITMD-CAP)

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The purpose of ITMD-CAP is to evaluate the ability of Army theater missile defense operations to protect maneuver forces and critical assets. The study evaluates Army capabilities in countering future missile threats in Northeast Asia in the 2002 timeframe. The analysis, by using simulation techniques, consisted of measuring the success of the Army active defense forces in preventing missile leakers from reaching critical assets, assessing the damage caused by the threat missiles that did penetrate the defenses, and then examining the impact on the entire theater campaign.

TBMD for an Amphibious Objective Area

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This presentation will describe a combat simulation-based analysis performed in support of the Navy Theater Ballistic Missile Defense (TBMD) Cost and Operational Effectiveness Analysis (COEA) in 1995. The Objectives of the analysis were to: (1) assess the impact of threat tactical ballistic missiles (TBMs) on U.S. Marine Corps amphibious assault operations; and (2) quantify the operational effectiveness of candidate TBM defense options to protect amphibious assault forces and operations within an amphibious objective area (AOA).

The scenario used in the analysis was a composite scenario, combining a detailed amphibious landing scenario which has been used by the USMC in previous COEAs, with the TBM threat drawn from a Ballistic Missile Defense Organization (BMDO) scenario. A force-on-force level simulation was used to calculate the effectiveness of candidate TBMD systems against threat TBMs fired at the AOA over a period of approximately three days of combat. The Corps Battle Analyzer (CORBAN) combat simulation was then used to assess the impact of the TBMs on a Marine Expeditionary Force (MEF) size amphibious assault, and to quantify the operational value of candidate TBMD systems.

The Active Defense/Passive Defense/Attack Operations/BMC4I Pillar Integration (APAB-PI) Model

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The purpose of APAB-PI is to evaluate the contribution of each pillar of theater missile defense (TMD), as well as an integrated TMD on the theater-level campaign. APAB-PI accomplishes this by applying the techniques of dynamic modeling to a low-resolution theater-level model. Instead of focusing on the effects of a single strike, APAB-PI examines the entire campaign. APAB-PI is used in sensitivity analyses, value added types of analyses, and wargame support.

<u>*Tuesday, 1530-1700*</u>
When Sleds Fly - Selecting the Best Alternative for Future High Speed Testing at the Holloman High Speed Test Track

Major Eileen Bjorkman,
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The Holloman High Speed Test Track (HHSTT) is used to create test environments for a wide variety of full-scale test articles, from low-speed ejection seats to high speed theater missile defense lethality tests. Current speeds on the track are limited to 2 km/sec. but speeds in excess of 3 km/sec are needed for many types of testing. In addition, the vibrations caused by the metal-to-metal contact on the present track creates a severe environment which requires substantial "beefing up" of test articles. The metal-to-metal contact also leads to frequent rail damage during high speed runs. The 846th Test Squadron is developing a new facility using magnetic levitation technology to overcome many of the present problems associated with the HHSTT. The facility is expected to be operational in FY99. A Test Capability Benefits Analysis (TCBA) was performed to determine the most cost effective approach to developing the magnetic levitation facility. This paper presents an overview of the current capabilities and shortfalls of the HHSTT and then shows the TCBA methodology and results used to select the current configuration of the proposed magnetic levitation facility.

C^2 Value Added Analysis for Theater Ballistic Missile Defense

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The objectives of this analysis are two fold. First is to develop techniques to quantify the value added by various C^2

options to Theater Ballistic Missile Defense operations. The second objective is to determine the edges of the performance envelope (best case/worse case) for the C^2 options.

This analysis leveraged off work done to support the Navy's Cost and Operational Effectiveness Analysis. The North East Asia (Near Term) Scenario is used for ship positioning, threat trajectories, raid density and system performance. Two top level Measures of Effectiveness are used in the analysis. These are the number of Theater Ballistic Missiles (TBMs) killed and the number of interceptors used to achieve the kills. The first measures the relative effectiveness of the various C^2 options and the second measures the relative efficiency of the options.

The C^2 options analyzed were fire coordination procedures, a positioning optimization technique and external cueing. Each option was evaluated singularly and in combination against an uncued, uncoordinated base case. System Planning and Analysis' Force Level Effectiveness Analysis Tool was used for this analysis. The heart of this tool is a very detailed, kinematic, one-on-one missile fly out model. To determine TBM kills, a constant single shot kill probability was assumed.

At the completion of this analysis, we are able to make an initial rank ordering of the C^2 options. This contributes to developing a time phased plan for delivering different C^2 TBMD capabilities to the Theater.

Early Warning Radar System Response to Limited Ballistic Missile Attacks

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Mr. Ronald Roehrich, Dr. David Finkleman,
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The objective of this investigation was to predict the timeliness and quality of information available for NORAD and USSPACECOM ballistic missile attack warning missions. This stud is the first to employ actual duplicate early warning radar mission processors now available through the Consolidated Integration Support Facility (CISF). Air Force Material Command (AFMC) operates the CISF to maintain early warning radar and other sensor system software and operational algorithms. We also took advantage of the newly operational Phase Array Radar System Emulator (PARSE) model, developed for AFMC by GRC and SAIC. Working with the National Test Facility, Air Force Space Command, and Air Force Material Command we were able to: validate analytical models of the early warning radars, predict precisely early warning radar observations of intelligence community certified hypothetical ballistic missile attacks on North America, and provide additional insight for senior officers who assess the nature of space and ballistic missile events. During this investigation, we discovered coverage and tracking deficiencies that the acquisition and operational communities remedied cooperatively and expeditiously. We also uncovered discrepancies in the CISF early warning radar test software. This project is a unique example of the interaction between resource providers (the acquisition and development community) and Combatant Commands that employ those resources. We demonstrated the valuable role of operational analysis in that interface.

<u>Wednesday, 0830-1000</u>

C4ISR and Deep Attack Weapons Mix Study (DAWMS) Modeling

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Approved abstract not available at printing.

Review of Link 16 Operational Utility Analyses

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Approved abstract not available at printing.

Value of BM/C4I to Joint Theater Ballistic Missile Defense

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Based on a recent POET study of Ballistic Missile Defense (BMD), of large theaters, such as Europe, against terrorist or blackmail-type attacks, effective BM/C4I is essential and results in very large cost savings.

The major BM/C4I components used included: space-based, stereo Tactical Ballistic Missile (TBM) detection and processing; timely, space-based relay of cueing data to ground radars; a Joint Composite Track Net (JCTN) to provide accurate radar track, discrimination and target designation on the TBM threat to shipboard battle management systems that launch high speed interceptors against the attackers (CEC-like operations); and the Global Positioning System (GPS) to accurately locate Òsensors and shooters.Ó

These BM/C4I components and operational concept could eliminate the need for a number of very expensive ship-based and ground-based radar upgrades and other sensor and interceptor developments. The savings offered by this approach will be ÒquantifiedÓ in the classified presentation. In addition to cost savings, the BM/C4I components necessary for implementation of this type architecture will be available much sooner than the alternative of massive sensor upgrades.

<u>Wednesday, 1515-1645</u>

Uncertainty and the National Ballistic Missile Defense Program

Col. David F. McNierney, Ms. Pauline N. Pakidis,
Ballistic Missile Defense Organization

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Approved abstract not available at printing.

Performance Measurement in Ballistic Missile Defense C2 Simulations

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Future Ballistic Missile Defense (BMD) command and control (C2) command and operations centers are being simulated in large scale hardware and software testbed environments (e.g., National Test Facility, Colorado Springs, CO) to assess new BMD operations concepts (CONOPS). Key simulation questions are, what are the optimal commander and staff roles and responsibilities in missile warning and engagement centers, and does C2 information flow within and among these centers to effectively support decision making? Until recently, immediate player feedback was the primary method of determining C2 efficacy, since early simulation efforts were most concerned with building the realistic BMD C2 operational environment.

The BMD C2 community has begun in earnest to integrate performance-based measurement and analysis into the C2 simulation process by introducing a systematic approach for evaluating individual and crew decision tasks during more controlled scenario-event conditions. This measurement strategy includes real-time direct behavioral observation techniques, automated data recording, player information and workload scaling instruments, and content analysis of player actions and commentary. Data from several successive simulations have now allowed the formulation of BMD C2 performance baselines and CONOPS excursions during varying information flow conditions. One promising technique for performance comparisons involves creating comprehensive operational sequence diagrams (OSDs) showing scenario events and player actions in a timeline diagram. The OSD and supporting information use data allow quantitative comparisons of C2 CONOPS and provide an empirical basis to substantiate information and decision interface designs.

Upward Traceability: An Approach to Reducing OT&E Costs

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Approved abstract not available at printing.

Thursday, 0830-1000
TriService Attack Operations Study: Contribution of Attack Operations to the Theater Missile Defense Mission

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The TRADOC Analysis Center is the Army's lead analytic agency for the Tri-Service Attack Operations Study (TSAOS) which is being conducted to assess the contribution of joint attack operations to the Theater Missile Defense (TMD) mission. Separate modeling, simulation and analysis is being conducted by the Air Force and Navy in conjunction with the work the Army is doing. These separate analyses will be integrated into one report and used to provide insight into Phase II of the Ballistic Missile Defense Organization (BMDO) TMD Cost and Operational Effectiveness Analysis (COEA), and for the Joint Chiefs of Staff JCS/J-8 Joint Strike Integration Working Group.

This presentation will begin by briefly covering the methodology used for the study. Emphasis will then change to focus on the importance of working together in a joint environment, and how to coordinate within the working group on different modeling, simulation and analysis techniques. Lessons learned during the interaction between the different services, and recommendations that will help optimize the Army's ability to plan and conduct future studies with other Services, will be presented. Finally, results from the analysis will be discussed, and how they will be used in support of the BMDO TMD COEA. The goal of the presentation is to generate meaningful discussion among the working group members using the insights gained during the TSAOS as a catalyst.

Joint Warfighting Capabilities Assessment (JWCA) Attack Operations Study

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The Joint Staff conducted an initial end-to-end assessment of the current and future Theater Missile Defense Attack Operations Mission Area Architectures. Six JWCAs (Command & Control, Strike, Sea-Air-Space, Land and Littoral Warfare, Intelligence Surveillance & Reconnaissance, and Counter Proliferation) collaborated to develop mission area architectures for the following tasks: destroy missile storage facility, destroy TEL/missile en route, destroy TEL/missile at the launch site, destroy missile post-launch.

The presentation will briefly cover the JWCA process and the attack operations study methodology. The final section of the presentation will focus on the modeling shortfalls encountered during the assessment.

The Contribution of TMD Attack Operations at the Campaign Level

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In support of the Ballistic Missile Defense Organization (BMDO)

Theater Missile Defense (TMD) Cost and Operational Effectiveness Analysis (COEA), USASSDC developed and applied a modeling approach to show the contribution of attack operations (AO) to campaign-level TMD. This paper explains the modeling approach, demonstrates its application, and presents example results, trends, and conclusions for the TMD benefit of AO.

To support the COEA in this task, a PC-based EXCEL 5.0 spreadsheet model was developed. Although spreadsheet based, the code is approximately 1.5 gigabytes in size and is a true simulation, tracking the time evolution of AO weapon availability, transporter erector launcher (TEL) inventories, asset flow into theater, and scheduled, attempted, and achieved theater ballistic missile (TBM) launches. Dr. Tim Naff, BDM Federal, Inc., was instrumental in the development of this model and the model was appropriately named the Naff Attrition Model.

The analysis used the same 80 day scenarios as the TMD COEA, including threat laydowns and launch schedules specifying TBM types, location, and launch times. Model outputs included the total number of launches attempted and achieved by day and by threat type, the numbers of missiles attritted either at launch site or at supply point, and the numbers of TELs attritted. These numbers were "rolled up" to yield the total percentage of scheduled TBM launches.

Combined Attack Operations/ Active Defense Effectiveness

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Approved abstract not available at printing.

<u>*Thursday, 1330-1500*</u>
AF BPI Study

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Approved abstract not available at printing.

Air Directed Air-to-Air Missiles

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Approved abstract not available at printing.

The Cruise Missile Defense Study

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Land Attack Cruise Missiles (LACM) are evolving into an advanced threat class. Service analysis efforts over the past three to five years have concluded that air defense systems need to be augmented by airborne sensors. With adequate airborne sensors and engager netting, engagements of the threat can be possible at extended ranges, well beyond the autonomous surface weapon systems' capabilities. In response to tasking from Dr. Kaminski (OSD USD(A&T)) and ADM Owens (Vice Chairman, Joint Chiefs of Staff), the Joint Staff is leading a multi-year effort to develop and objective architecture which will provide a robust capability against the emerging cruise missile threat. To obtain this objective architecture the study members will need to examine in detail the engagement and Battle Management architecture implications for Joint cruise missile defense operations in a complex air defense environment.

The Defense Science Board's Cruise Missile Defense Summer Study (Summer 1994) stated that "Cruise missile defense is not a separate activity but is part of theater air defense. Integrating Service activities into an effective joint air defense requires new arrangements within and between the warfighter and acquisition communities." Executing a study that must posit a target joint integrated architecture, where only Service component architectures currently exist in stovepipe activity in research, development, acquisition and on the battlefield, is a challenge for the operations research community. Representing component force elements in an integrated fashion at the force-on-force level will require and exceptional degree of engineering and systems level cooperation across Service and Agency boundaries, and an exceptional approach to modeling and analysis. Key to this approach is the early, continuous and direct involvement of the CinC warfighters and the Service/Agency technical communities in the analysis planning and execution. Wargames and workshops, fed with current technical analysis, will involve the warfighter in the assessment of system performance trades and operational concepts.

This approach requires continuous interactions between the technical and operational elements of the Study team. Products will be produced Jointly. Data and concepts presented to the Study will have the benefit of Service and Agency participation at all levels in a collaborative forum.

WG 2 — ISSILE DEFENSE — Alternates

Exploring Boost Phase Intercept Concepts for Theater Missile Defense

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The purpose of this paper is to provide an independent assessment of various boost phase intercept concepts for negating ballistic missiles possessed by third world nations. Interceptor performance and potential capabilities are presented. Various ballistic missile parameters are examined, particularly with regard to time of powered flight. The boost phase intercept (BPI) concepts examined include long range (400 n mi) sea launched and air launched interceptors. Short range (100 n mi) interceptors based on unmanned aircraft are also included. The capabilities of interceptors against SLBMs and ICBMs are noted, particularly with respect to concerns about arms control between Russia and the United States and the security of their strategic forces.

Deep Attack Weapons Mix Study (DAWMS) Methodology

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U-2 in Support of Special Operations

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There is an urgent and growing need to leverage technologies and capabilities in revolutionary ways to provide in-time intelligence support at all levels, including the individual warfighter. The paper explores feasible options for exploiting U-2 Reconnaissance System capabilities, beyond their traditional role, to provide solutions to Air Force Special Operations Command (AFSOC) operational intelligence deficiencies identified in formal requirements documents. The paper discusses how the combined elements of aircraft performance characteristics, sensor capabilities, data links, and ground processing stations make the U-2 a unique system to support the critical needs of special operation forces (SOF) for near-real-time intelligence.

A representative scenario is included that illustrates specific examples where U-2 capabilities could provide in-time intelligence during the mission planning, rehearsal and execution timelines. With the U-2 likely to already be operating where SOF are employed and the connectivity between the U-2 CARS ground station and AFSOC intelligence support systems already existing within the current C4I architecture, the paper concludes that U-2 capabilities can be effectively integrated in support of AFSOC requirements. However, an increased understanding of each other's capabilities and mission requirements within the U-2 and SOF communities is needed to realize the full potential of integration.

Theater Missile Defenses and Russian Retaliation Issues

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The purpose of this paper is to provide an evaluation of the effects of deployments of theater missile defenses in the homelands of the United States and Russia. The focus is on the potential degradation of the Russian warplan (RISOP) if such deployments were to take place, and the United States were to implement a first strike against Russian targets. Means of restoring the effectiveness of a Russian retaliation are examined by using more forces and the deployment of decoys to accompany ballistic missile warheads. Further, assessments of first strike stability are made under a variety of conditions, including the use of decoys for reentry vehicles, and a lopsided case where Russia deploys a homeland defense, but the United States does not.

System-Level Evaluation Methodology for Assessing theUtility of Data Fusion Systems

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Approved abstract not available at printing.

Parametric Trade-Off Analysis: Interceptor Burnout Velocity versus Radar Range

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Approved abstract not available at printing.

The Battle for Seoul

Mr. John Rybicki
BDM Federal, Inc.

Approved abstract not available at printing.

WG 3 — ARMS CONTROL AND PROLIFERATION — Agenda

Chair: Bob Batcher, USACDA
Cochair: MAJ Joe Hogler, USSTRATCOM/J533
CAPT Sylvia Ferry, HQ DNA/PMCT
Advisor: Alfred Lieberman, FS, USACDA
Room: GIF, 351-D

Tuesday, 1030-1200
Balkan Arms Control: A Bosnian Notional Proposal
John E. Peters, RAND Corporation

Controlling Conventional Arms Transfers
Kenneth Watman, ASD(S&R) R&P

Tuesday, 1530-1700
COMPOSITE GROUP I SESSION .... **GIF, Dupuy Auditorium**

Wednesday, 0830-1000
Ballistic Missile Defenses and Russian Retaliation Issues
Frederic Nyland, U.S. Arms Control and Disarmament Agency

The ABM Treaty: A Technical Yardstick to Measure Guidance
Stephen Bauer, Science Applications International Corporation

Deterrence in the Post-Cold War World
MAJ Andy Manley, AF/XOXI and Lawrence S. Wolfarth, TASC

Wednesday, 1330-1500
Evaluation of Commercial Equipment for On-site Chemical Identification during Chemical Weapons Convention Verification Inspections
Jean E. Razulis, U.S. Army Chemical and Biological Defense Command

PC-Based On-Site Inspection Training Tool: "Augmented Table-Top Inspection Exercise"
Sharon M. DeLand, Sandia National Laboratories and Mr. Karl Horak, Ogden Environmental and Energy Services

Wednesday, 1515 - 1645
The CTBT - A Vital Non-Proliferation Tool or a Threat to the United States
Randy R. Ridley, TASC

Comprehensive Test Ban Treaty -- Status of the Negotiations
Robert G. Gough, Sandia National Laboratories

The U.S. Purchase of Highly Enriched Uranium from Dismantled Russian Warheads--Requirements and Issues
Catherine A. Williams, TASC

Thursday, 0830-1000
Hazard Prediction and Assessment Capability (HPAC)
LTC A. J. Kuehn, Defense Nuclear Agency

Munitions Effects Assessment (MEA) Weaponeering/BDA Tool
Mike Giltrud, Defense Nuclear Agency

Thursday, 1330-1500
The State of the Art Terrorism: A Case Study of the Aum Shinrikyo Cult and its Weapons of Mass Destruction
Kyle Olson, TASC

The Consequences of the Proliferation of High Resolution Imaging Technology
Darrell C. Sheehan, TASC

Post Cold War Trends in Disarmament
Eric E. Desautels, TASC

WG 3 — ARMS CONTROL AND PROLIFERATION — Alternates

Exploring Boost Phase Intercept Concepts for Theater Missile Defense
Frederic Nyland, U.S. Arms Control and Disarmament Agency

Aircraft Attacks on Mobile Missiles
Frederic Nyland, U.S. Arms Control and Disarmament Agency

Next Generation Arms Control and Security
Randy Ridley, TASC

Analysis of Virtual Nuclear Arsenals
Robert T. Batcher, U.S. Arms Control and Disarmament Agency

Conventional Armed Forces in Europe (CFE) Treaty Elements, Issues and Measures of Effectiveness
Dorn Crawford, U.S. Arms Control and Disarmament Agency

WG 3 — ARMS CONTROL AND PROLIFERATION — Abstracts

Tuesday, 1030-1200
Balkan Arms Control: A Bosnian Notional Proposal

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This paper examines sub-regional conventional arms control in Europe by sketching out a notional arms control and security regime for Bosnia. The exercise illustrates the difficulties awaiting an attempt at a local arms deal, but also highlights the contribution that arms control could make. If arms control is to produce something meaningful in the Balkans, it must draft a new definition of "stability" that is germane to the area's troubles; it must identify and control the weapons that are militarily significant in the local context, despite the attendant problems of verification; and it must craft a local military balance among the parties that is adequate for legitimate defense but that will afford no faction a military advantage over another . This paper illustrates how operational definitions for stability could be designed to address specific Balkan sources of conflict and how these definitions could be used to shape specific arms control measures. It offers some new notions of military significance for evaluating weapons as prospective treaty limited equipment. Finally, the paper offers a proportionality calculus for a regional military balance and offers some proposals for rebuilding local trust and confidence in public figures and institutions.

Controlling Conventional Arms Control Transfers

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The Iraqi invasion of Kuwait renewed attention to the potentially destabilizing impact of the accumulation of advanced systems in regions such as the Middle East, both conventional weapons and weapons of mass destruction. This study addresses the problem of the proliferation of conventional weapons systems and has developed an approach for controlling conventional arms transfers to the Persian Gulf region.

The primary impact of limiting the transfer of conventional arms is on the military forces that otherwise would be incorporating them. The objective of a control regime should be to limit weapons that, if sold, would affect regional military balances in ways inconsistent with U.S. strategic interests. There are two types of balances that could be affected: interregional and intraregional. For the Persian Gulf, the interregional balance dominates, since the foundation for deterrence of Iraq or Iran is the threat of U.S. intervention. Therefore, the primary objective for a control regime applied in the Persian Gulf is to affect the interregional balance --the balance between the United States and potential regional adversaries--favorably. In other regions, the intraregional balance may be more relevant.

Three criteria guided the identification of weapons for inclusion in a control regime for the Persian Gulf. The first is "high leverage:" The systems included should exert an especially powerful influence on battlefield outcomes. The second is "low substitutability:" The systems included should have no substitutes such that users can replace them by buying from a supplier outside the regime. The third is "low opportunity cost:" The opportunity cost for the foregone sales incurred by states adhering to the control regime should be low.

The briefing will discuss the general characteristics of an international control regime, including the end items to be controlled, permitted ceilings, criteria for application of the regime, and mechanisms for its implementation.

Tuesday, 1530 - 1730
COMPOSITE GROUP I SESSION
GIF, Dupuy Auditorium

Wednesday, 0830-1000
Ballistic Missile Defenses and Russian Retaliation Issues

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The purpose of this paper is to provide an evaluation of the effects of deployments of theater missile defenses in the homelands of the United States and Russia. The focus is on the potential degradation of the Russian war plan (RISOP) if such deployments were to take place, and the United States were to implement a first strike against Russian targets. Means of restoring the effectiveness of a Russian retaliation are examined by using more forces and the deployment of decoys to accompany ballistic missile warheads. Further, assessments of first strike stability are made under a variety of conditions, including the use of decoys for reentry vehicles, and a lopsided case where Russia deploys a homeland defense, but the United States does not.

The ABM Treaty: A Technical Yardstick to Measure Guidance

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The US and other ABM Treaty successor states have been discussing the difference between the strategic and non-strategic defenses against ballistic missiles. One of the key questions in such discussions is whether certain space-based sensor systems have or could have the capability to "guide" ballistic missile interceptors. Since the ABM Treaty provides no definition of "guidance," SAIC was tasked to provide technical assistance to ACDA by (1) describing definitions of guidance for ballistic missile interceptors from the engineering perspective, (2) describing how space-based sensors can augment, enhance, or obviate the need for ground-based interceptors, and (3) defining a "yardstick" to measure the continuum of these capabilities. The yardstick was tested against some notional generically different interceptor designs to test its usefulness.

Deterrence in the Post-Cold War World

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Following the end of the Cold War, the focus of U.S. national security strategy shifted from containment of the Soviet Union to the prospect of military intervention in regional conflicts. Fundamental Cold War concepts such as deterrence have come under renewed scrutiny in an effort to identify the requirements, conditions, and limitations in the changing international environment. Specifically, this paper will examine the deterrent value of nuclear weapons in the post-cold war era. Associated concepts and issues will also be addressed; these include: credibility of intent, asymmetrical perceptions of "unacceptable losses," bargaining, and the prospect of extending deterrence to regional allies. This analysis will contribute to our understanding of complex regional deterrence equations and the relevance to U.S. defense planning and future international stability.

Several previous studies employed non-linear complex models of international relations. In 1960, Richardson used a relatively simple model of a two-nation arms race to illustrate that the reciprocal feedbacks inherent in the response-counterresponse cycle may or may not undermine rational leaderhips' attempts to produce long-term flows toward their desired policy objectives. Since the mid-1980s, Saperstein, Mayer-Kress, Wolfarth and Hill, Miller and Sulcoski and others expanded the basic two-nation model to three or more nations in order to understand the effect of coalition building on international stability. The paper will apply a Richardson-like model of complexity to understand the value and limitations of U.S. nuclear deterrence in the post-Cold War world. In the relative absence of superpower competition, it is instructive to identify the conditions and relationship that could underlie successful deterrence policies.

The Middle East serves as the region for analysis. The methodological approach utilizes models of complexity to analyze historical data and to observe non-linearities and model results. These non-linearities suggest areas for further research. One anticipated result is that U.S. nuclear weapons will not affect most regional actors because of weak causal linkages between the military behavior of the U.S. and potential adversaries. Another potential result is that states which do respond to U.S. military behavior and political influence will react in unexpected ways that are described by the models examined.

Wednesday, 1330-1500
Evaluation of Commercial Equipment for On-site Chemical Identification during Chemical Weapons Convention Verification Inspections

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The United States supports the Chemical Weapons Convention (CWC) position on chemical sample analysis during CWC verification inspections. The Convention allows on-site and off-site chemical sample analysis, favoring on-site analysis where possible. Since 1989, the U.S. Army Chemical and Biological Defense Command (CBDCOM) has been researching and developing on-site sample analysis methodologies and technologies for CWC verification inspections (routine and challenge). As part of the R&D program, the CBDCOM has developed and is using a trade-off analysis approach to evaluate commercial equipment for on-site chemical identification. The approach identifies and compares candidate equipment against comprehensive performance criteria using data from laboratory experiments, field tests, and actual use. The analysis determines

the degree to which commercial items meet the CWC verification aims and requirements for on-site verification inspections. This paper presents the trade-off approach and preliminary analysis results.

PC-Based On-Site Inspection Training Tool: "Augmented Table-Top Inspection Exercise"

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Mr. Karl Horak
Ogden Environmental and Energy Services

Many current and proposed arms control agreements have on-site inspection requirements. Several government facilities and private firms may be subject to these agreement-mandated on-site inspections. Sandia National Laboratories and Ogden Environmental and Energy Services have developed a PC-based on-site inspection training tool, the Augmented Table Top Inspection Exercise (ATTIE), that provides hands-on experience with the procedures used in inspecting and hosting international inspections.

ATTIE allows (1) participants to view rooms and to remove shrouds, (2) disparate inspection-relevant data to be geographically referenced, (3) all data sources to be reached from a single interface, and (4) the training exercise to stay on schedule by using an exercise control clock. This provides a more realistic training course than current table-top inspection exercises at lest cost than mock inspections.

ATTIE integrates a suite of Windows®-based commercially available software using customized menus, specialized databases, and data display programs.

- AutoCAD® -- a graphics engine for visualization and navigation tools for site and building maps;
- ArcCAD® -- a geographical information system for point-and-click ability to query a map by spatial means;
- Access® -- a relational database;
- ZyIndex® -- a text retrieval system; and
- Visual BASIC® -- a development environment for the exercise control clock and the data display viewers for different types of information (hazardous waste, CRADAs, ES&H information, equipment inventory, photographs, and animations).

Wednesday, 1515 - 1645
The CTBT - A Vital Non-Proliferation Tool or a Threat to the United States

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The Comprehensive Test Ban Treaty (CTBT) is the next high priority on the U.S. arms control agenda. Public opinion is clear - the test firing of nuclear weapons is abhorrent. Yet the United States has traditionally relied on its nuclear deterrent capability to ensure that nuclear weapons would not be used against the United States. Many advocates of the CTBT have cast its value in proliferation terms - in other words a CTBT is necessary to stem nuclear proliferation world-wide. Others in the public sector have stated that the CTBT is the first step in the de-legitimization and ban of nuclear weapons. In the past, many, including DOE lab experts, have cast doubt on the U.S. ability to maintain a reliable, safe, and optional nuclear force structure under a CTBT regime. The current administration is highly supportive of a CTBT, however many Republicans in Congress have serious questions about the value of the CTBT for the United States. This paper will examine many of the national security questions surrounding a CTBT including:

- **Is the CTBT a proliferation tool?** Under a CTBT, what will the treaty remedies be to stem proliferation? What are the non-treaty affects that might proactively stem proliferation?
- **What are the verification challenges under a CTBT?** How effective would the proposed international regime be? Is the CTBT verifiable?
- **Varying effects**. The CTBT will affect the world's nations differently. What are the contrasts between the U.S. and other major nuclear powers, minor nuclear powers, nuclear wannabees and non-nuclear states?
- **Risk for the United States?** What is the reasonable level of risk for the United States under a CTBT? Can the U.S. stockpile be maintained? Will the U.S. be able to count on an effective nuclear deterrent in the years ahead? To what extent will the CTBT positively affect the national security of the United States?

Comprehensive Test Ban Treaty - Status of the Negotiations

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Negotiations of the Comprehensive Test Ban Treaty (CTBT), a goal of the international community for many years, are now in what the U.S. calls the "end game". Indeed, the Clinton Administration has established a goal of completing the Treaty in June in order to allow signature this Fall. Reflecting the timeliness of the MORS Symposium to these evolving negotiations, this presentation will summarize the state-of-play of the negotiations and offer a contextual basis for OR analysts who may wish to delve deeply into various details of the CTBT and its verification regime.

Although many CTBT issues have been agreed as of the writing of this Abstract, a number of others remain unsettled among the nearly 100 negotiating delegations. Among those currently unresolved are: 1) scope of the Treaty and activities not prohibited, including "true zero yield", peaceful nuclear explosions (PNEs) and how best to protect R&D on Inertial Confinement Fusion (ICF); 2) final configuration of the International Monitoring System (IMS); 3) the role of non-IMS data, including those from National Technical Means; 4) functions to be performed by the International Data Center (IDC); 5) on-site

inspection (OSI) modalities, especially permissible mechanisms to trigger such inspections; and 6) requirements for entry-into-force of the Treaty.

The U.S. Purchase of Highly Enriched Uranium from Dismantled Russian Warheads--Requirements and Issues

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Since the end of the Cold War, the proliferation of fissile materials has rapidly become one of the greatest global security threats. As Russia and the United States began dismantling warheads, the amount of fissile material was rapidly increasing. However, during the Bush Administration, some innovative policy makers and corporate executives negotiated a plan which would not only keep a good deal of this material in safe hands, it would also be put to good use as nuclear reactor fuel.

The agreement requires the United States to purchase a fixed amount of highly enriched uranium (HEU) from dismantled Russian warheads over twenty years. The U.S. will be able to de-enrich the material and sell it on the open market as reactor fuel. Russia will receive millions of dollars of needed currency and additional aid for maintaining and protecting their fissile material storage facilities.

The HEU purchase is a truly unique arrangement between the U.S. and Russia. Although it was prompted by a mutual concern for fissile material proliferation, its intent is purely economic. It is also very likely that similar arrangements could be applied to additional proliferate materials in Russia and in other countries. This paper examines both the development and implementation problems of this unusual dismantlement initiative. Specifically, the paper will discuss:

- The unique bureaucratic politics involved in the negotiations, including the creation of the "corporation" which would actually make the purchase.
- The economic elements of the arrangement, including the potential for resale profit made from de-enriched uranium on the world market and the protection of miners from Russian uranium dumping.
- The U.S. and Russian benefits from the purchase both economically and diplomatically.
- The shortcomings of the agreement, especially the exclusion of plutonium in the purchase.
- The prospect that similar "business" arrangements will be modeled on the HEU purchase.
- The unique "buyer/seller" requirements and issues.

<u>*Thursday, 0830-1000*</u>
Hazard Prediction and Assessment Capability (HPAC)

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HPAC models all nuclear, biological and chemical (NBC) collateral effects of concern to military operations. These may derive from the use of NBC weapons or from conventional weapons strikes against production and storage facilities for such weapons. Similar effects may result from military or industrial accidents.

Multiple platforms host the HPAC tools.

A PC-based model, HASCAL, provides source information on potential radioactive releases from a nuclear reactor accident as well as downwind doses for assessing radiation health effects. DNA is expanding HASCAL's capability to generate source terms for chemical and biological weapons and facilities and to transport those sources atmospherically to predict a realistic downwind hazard.

A workstation-based approach, MEDOC, involves adapting a suite of meteorological codes developed for the nuclear power industry to military applications. These codes focus on local and regional scale atmospheric transport involving complex terrain and operate in either a forecast (prognostic) or nowcast (diagnostic) mode.

The supercomputer-based atmospheric forecast system, OMEGA, is advancing the state-of-the-art in numerical weather forecasts to enable increased accuracy of wind forecasts and improved prediction of hazardous aerosol and gas transport in the theater of operation. The OMEGA unstructured grid can readily adapt to the local or regional scales required to account for terrain and weather effects . DNA can also provide enhanced grid resolution in localized regions for a theater commander interested in accurate wind forecasts.

Munitions Effects Assessment (MEA) Weaponeering/BDA Tool

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The MEA provides a pre-attack weaponeering tool for high value fixed targets. The models include:

- Aim point recommendations
- Graphical depictions of physical and functional damage
- Case-based library of pre-weaponeered targets
- Open-ended weapon effects analysis methods
- Probability of kill with confidence levels
- Prediction of target generated collateral effects

The post-attack battle damage assessment tool portion of the MEA provides:

- Exploitation of signatures from Desert Storm and peacetime testing
- Gun camera videos (to provide damage keys)
- Plumeology (blast, venting, kinetic energy, and incomplete combustion signatures)
- Still imagery damage signatures (penetration holes, craters, secondary explosions)
- Reverse engineering of target damage based on weapon performance

The MEA's Weaponeering/BDA Tool will be a JTCG/ME

Special Report planned for publication in early calendar year 1996. Future integration plans call for MEA inclusion in the Service's planning tools.

Thursday, 1330-1500

State of the Art Terrorism: A Case Study of the Aum Shinrikyo Cult and its Weapons of Mass Destruction

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The terrorist potential of chemical and biological agents had long been the stuff of nightmares when the Aum Shinrikyo -- the Supreme Truth cult -- launched its sarin nerve gas attack in the tunnels of the Tokyo subway. The fateful events of March 20, 1995 shook the complacency of police and civil defense planners around the world, as yet another taboo fell. Subsequent investigation has revealed a vast, well-financed network of criminal and business activities, reaching around the world and raising important questions about the international community's ability to detect and deter terrorist use of weapons of mass destruction.

This paper will describe not only the Tokyo subway attack itself, but also the actions leading up to the fateful day...events that should have provided ample warning of the danger. It will discuss the failures of intelligence and law enforcement authorities in Japan, the U.S., and elsewhere, to identify the Aum Shinrikyo threat. It will provide a look at the ease with which this well financed but relatively unsophisticated group was able to carry out large scale operations on five continents intended to provide it with a chemical, biological, and even nuclear weapons capability. It will suggest logical steps to address the increased potential for the use of weapons of mass destruction by sub-national groups.

This paper presents exclusive information collected from Japanese, Russian, Australian, and American sources, and provides a detailed examination of the challenges confronting efforts to pre-empt an even more lethal repeat of the subway incident.

- **Smuggling of Weapons of Mass destruction: Requirements for Controlling Arms and Countering Terrorism**. Addresses how the Aum Shinrikyo acquired their weapons capability, with particular emphasis on their use of open source US and Russian information, as well as their participation in the emerging technology "black market".
- **Implementing Arms Control Agreements and Initiatives**. The cult's construction of a large chemical weapons production factory in the shadow of Mount Fujiyama suggests the verification challenges ahead for the Chemical and Biological Weapons Conventions.
- **Export Controls: Roles, Problems, and Promise**. The Aum Shinrikyo chemical weapons program was carried out in almost plain sight, openly purchasing key equipment and raw materials from vendors operating in full compliance with applicable controls and regulations. What strategies can be effectively implemented to address the increasing ubiquity of critical dual-purpose technologies and expertise?

The Consequences of the Proliferation of High Resolution Imaging Technology

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High resolution satellite imagery was developed as a crucial intelligence product during the Cold War. Now United States warfighting capabilities rely upon state-of-the-art imagery technologies to maintain battlespace dominance throughout the world. Command, control, communications, and intelligence (C3I) for our forces depends upon both maintaining technological superiority in imagery collection and the denial of that capability to potential adversaries.

While technological advances have improved capabilities and reduced costs, commercial utilization of imagery products has grown considerably. This highly profitable market is the target of intense international competition. As United States industry struggles to compete in the commercial imagery market, the U.S. defense community has become concerned that commercial innovations in imagery technology may offer adversaries cheap and easy access to intelligence with warfighting applications.

This paper investigates the positions of both the defense community and the commercial sector. Both positions are analyzed to determine the consequences of the spread of commercial high resolution imagery. The following points are addressed:

- **Historical Background.** A brief overview of the history of commercial imagery and its long interrelationship with military and intelligence technologies.
- **Eye on Technology**. The state of existing technologies are described for the layman. Future capabilities are forecast for the near future.
- **The International Marketplace**. Who buys imagery products and why do they want them? Diverse clients such as Sadam Hussein and environmentalist groups are reviewed.
- **The Industrial Competition**. A comprehensive examination of the commercial sector identifies the states and organizations that fuel the proliferation of high resolution imaging.
- **U.S. Government Role**. Forced to protect both defense capabilities and industrial interests, the U.S. Government plays a central role in the control of imaging technologies. Current legislation and the consequences of proposed legislation are reviewed.
- **The Consequences**. The paper emphasizes the double edged-sword applications of high resolution imagery. Military intelligence capabilities and peaceful uses to promote openness, conduct arms control verification, and monitor environmental conditions are discussed.

Post Cold War Trends in Disarmament

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There is an inherent stability that arises from a bipolar world so long as deterrence does not fail. During the Cold War, deterrence led to a period of peace and stability unparalleled in the history of Europe. Yet, today there is a noticeable lack of bipolarity in the world. The Soviet Union has been replaced by a number of fragmented states that are mired in ethnic conflicts. The United States has also stepped back, becoming the reluctant hegemon. The lack of bipolarity in the international system has led to two contradictory trends in disarmament.

In the disarmament and dismantlement of the strategic arsenals of the former Cold War adversaries, the trend in recent years has been to reduce the arsenals further and faster. The START I Treaty has finally entered into force, paving the way for massive reductions in the nuclear arsenals of the United States and the former Soviet Union. This has opened the way for the entry into force of the next step in the disarmament process, the START II Treaty. There are even preliminary discussions underway on a START III Treaty. These Treaties continue a long trend of cooperation and disarmament between the two major nuclear powers.

On the other hand, the lack of this bipolarity and the cutbacks in the armed forces of the superpowers has led to a shift in the Third World away from disarmament towards a trend of increased armament. The lack of the Cold War security assurances has led many nations to look within themselves for security. For this reason, nations have sought to increase the capabilities of their military through the acquisition of high technology weapons systems and through the development of delivery systems for weapons of mass destruction.

This paper will examine:

- The disarmament trend between the United States and the former Soviet Union. Specifically in regards to nuclear disarmament and conventional reductions.
- The disarmament trend among Third World nations. Specifically the trend in recent years that despite decreases in military spending, these nations have increasingly sought more technologically advanced weapons systems.
- The trends in controlling the proliferation of weapons, both conventional and nuclear on both an international and bilateral scope.
- The effects of international events on this process. Specifically the effects of the Gulf War on the conventional disarmament process and the events in Chechnya on the strategic disarmament process.
- The future of arms control and disarmament.

WG 3 — ARMS CONTROL AND PROLIFERATION
Alternates

Exploring Boost Phase Intercept Concepts for Theater Missile Defense

Frederic S. Nyland
ACDA Consultant
P.O. Box 1674
Idaho Springs, CO 80452
Phone: (303) 567-2163

The purpose of this paper is to provide an independent assessment of various boost phase intercept concepts for negating ballistic missiles possessed by third world nations. Interceptor performance and potential capabilities are presented. Various ballistic missile parameters are examined, particularly with regard to time of powered flight. The boost phase intercept (BPI) concepts examined include long range (400 n mi) sea launched and air launched interceptors. Short range (100 n mi) interceptors based on unmanned aircraft are also included. The capabilities of interceptors against SLBMs and ICBMs are noted, particularly with respect to concerns about arms control between Russia and the United States and the security of their strategic forces.

Aircraft Attacks on Mobile Missiles

Frederic S. Nyland
ACDA Consultant
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This presentation examines the possibilities of employing aircraft of different types to implement a policy of countering the proliferation of mobile missiles after they have been procured and deployed by Third World nations. The missiles in question could be cruise missiles or ballistic missiles. The mission implementation would be carried out by conducting search and destroy missions against the deployed missiles. The analyses described represent a framework for examining issues such as the type of aircraft to be used, the location of real and decoy targets, and the confidence with which such operations might be pursued. Many parameters are uncertain, and variations of these parameters are made to show their effects.

Next Generation Arms Control and Security

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With the end of the Cold War, as with the end of World War II, the world has entered a period of new alignment and some degree of instability. However, with uncertainty has also come opportunity. Many new and far reaching arms control treaties have been signed, are in negotiations, or are being implemented. INF, CFE, START I, II, and III, the CWC, the BWC, CTBT, and Open Skies have created or will shape a new security environment in the 2000-2020 timeframe. However, each treaty is, in most cases, negotiated and implemented on its own merits. The comprehensive nature of the security environment that will be heavily influenced by the confluence of these arms control agreements is as yet unknown.

This paper will explore the "new parameters" of the global security environment beyond the year 2000 and the role of arms control in that environment. Specific sections of the paper will focus on addressing these key questions:

- **Regional Arms Control**.. To what extent does the current set of arms control tools enhance or detract from stability in key regions such as the Middle East, North

East Asia, and South and Central Asia? Can we expect arms control tools to solve problems in these regions?

- **Next Generation Arms Control Tools**. What are the new tools that are necessary in a multi-polar regional focused world to ensure stability? What can be the role of technology verification in these new tools?
- **The Role of Super Power**. Given the combined effects of a world with a number of arms control agreements, what are the new operating parameters that the world's only conventional super power in the world must live with? What are the reasonable limits on the use of military force? What is the optimal role that the U.S. should try to play?
- **Systems and Force Structure Limitations**. What are evolving and likely combined military systems limitations that the U.S. and other major powers will have to live with given INF, CFE, START I, II, and III, the CWC, the BWC, CTBT, and Open Skies and their successors? If current trends continue what kind of basic capabilities will these powers possess?

Analysis of Virtual Nuclear Arsenals

Robert T. Batcher
U.S. Arms Control and Disarmament Agency
320 21st St., N.W., Room 4930
Washington, DC 20451
Phone: (202) 736-7396

Proposals have been made to base the future of nuclear arms control on the concept of "virtual" nuclear arsenals. This concept purports to de-emphasize nuclear weapons by purposefully placing them in such a low state of readiness that time-consuming actions are required to make them available for use. The most often suggested technique is to separate or "de-mate" critical components (e.g., reentry vehicles, warheads, or guidance packages) from ballistic missiles. This paper examines survivability, stability, and verifiability issues associated with applying the virtual arsenal concept to future strategic arms control.

Conventional Armed Forces in Europe (CFE) Treaty Elements, Issues and Measures of Effectiveness

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Since the signing of the CFE Treaty in November 1990, the transformation of European security it embodies has proceeded apace, though certainly not without lingering difficulties and challenges. The 34 nations convened there under the auspices of the Conference on Security and Cooperation in Europe, of CSCE, are now 52; the 22 original parties to the CFE Treaty, signatories of either the erstwhile Treaty of Warsaw or the North Atlantic Treaty, are now 30. The unprecedented reduction of conventional armaments in the region has been largely completed. CSCE is now the Organization on Security and Cooperation in Europe, or OSCE.

The CFE Treaty itself is a highly complex undertaking of twenty-three articles and associated protocols, with the full English text running to some 110 pages. Associated reports, notifications, and information exchanges to date already yield ample new metaphors for our concept of an 'information explosion'. This overview is a self-conscious effort to distill and simplify the central aspects of the Treaty and associated documents, focusing on aggregate equipment and manpower limits, holdings, liabilities, and sites.

The analytical task this effort represents is a familiar one: seeking adequate measures of effectiveness that economically convey the main thrust of the phenomenon observed. Trading off simplicity against precision, impact against detail, concept against comprehensiveness are at the heart of scientific inquiry, and adequate oversight of a major arms limitation treaty should certainly meet that standard. Reviewing and discussing means and measures employed in this pursuit should thus be of interest to analysts as well as policy makers.

The evident premise of this work remains the old but still operative bromide that holds a picture to be worth a thousand words. The object is to portray in a handful of graphics and accompanying narrative the key features of the CFE regime, providing the reader a quick survey and reference, as well as an update on issues of continuing interest as Treaty implementation is concluded and long-term application begins.

WG 4 — REVOLUTION IN MILITARY AFFAIRS — Agenda

Chair: Mr. Michael G. Miller, Aegis Research Corporation
Co-Chair: Mr. James Calpin, MITRE Corporation
Co-Chair: Mr. Thomas G. Mahnken, Olin Institute, Harvard University
Advisor: Dr. Thomas Welch, Office of the Secretary of Defense
Room: GIF, 352-C

Tuesday, 1030-1200
The Revolution in Military Affairs - Issues, Trends, and Questions for the Future
Mr. Tom McKendree, Hughes Aircraft Company

Tuesday, 1530-1700
COMPOSITE GROUP I SESSION .... GIF, Dupuy Auditorium

Wednesday, 0830-1000
The Revolution in Military Affairs - Wonderland or Quagmire?
Dr. Thomas P. Rona, Technical Consultants

Wednesday, 1330-1500
The Revolution in Military Affairs - Dominating the Challenge-Response Cycle
Messrs. Daniel B. Fox and Samuel B. Gardiner, RAND

Wednesday, 1515 - 1645
The Revolution in Military Affairs - Information Warfare Concepts and Planning Applications
Messrs. Edmund M. Glabus and Daniel J. Gallagher, Aegis Research Corporation

Thursday, 0830-1000
The Revolution in Military Affairs - IW/C2W and CINC Support
Mr. William F. Swart, Joint Command and Control Warfare Center

Thursday, 1330-1500
The Revolution in Military Affairs - Needs and Effectiveness of the Digitized BattleForce - The Advanced Warfighting Experiment Series
CAPT Ken Pankratz, MAJ John Larsen, LTC Stan Ritter, TRADOC Analysis Center

WG 4 — THE REVOLUTION IN MILITARY AFFAIRS — Abstracts

Tuesday, 1030-1200
The Revolution in Military Affairs - Issues, Trends, and Questions for the Future

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Approved abstract not available at printing.

Tuesday, 1530-1700
COMPOSITE GROUP I SESSION
GIF, Dupuy Auditorium

Wednesday, 0830-1000
The Revolution in Military Affairs - Wonderland or Quagmire?

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Approved abstract not available at printing.

Wednesday, 1330-1500
The Revolution in Military Affairs - Dominating the Challenge-Response Cycle

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The research discussed in this briefing was conducted to generate insights on impact of evolving concepts of operations and new technologies in future wars. In the course of this research we conducted 12 war games used to generate ideas about the nature of revolutions in military affairs, to begin to define alternative

concepts of operations for both the U.S. and potential enemies, and explore the impact of technologies on warfighting and war. We posited a working definition for a revolution in military affairs as a situation allowing one side to dominate at least one aspect of a military conflict. One product of the games was an understanding of process working to resolve the tension between competing military capabilities, a tension that we characterized as a cycle of challenges and responses. In our games the competition emphasized asymmetric means toward ends, and focused on perceived U.S. weaknesses. The very fact that the U.S. develops certain capabilities ensures that competitors examine ways to circumvent our strengths. Thus, the U.S. plays a role in defining the nature of the threats we face in the future. A thread that permeated the challenges and responses in our games was the notion that enemy challenges tended to be based on alternative concepts and idea based. U.S. responses were very often technologically based. The implication was that ideas could be adopted more rapidly and at less cost than new technologies could be developed. It is important that we understand the nature of the challenge response cycle and develop not only flexible military hardware but agility in our command structure, to ensure that we not only stay inside an enemy's decision cycle but that we dominate the learning cycle.

Wednesday, 1515 - 1645
The Revolution in Military Affairs - Information Warfare Concepts and Planning Applications

Messrs. Edmund M. Glabus and Daniel J. Gallagher
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Approved abstract not available at printing.

Thursday, 0830-1000
The Revolution in Military Affairs - IW/C2W and CINC Support

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Approved abstract not available at printing

Thursday, 1330-1500
The Revolution in Military Affairs - Needs and Effectiveness of the Digitized BattleForce - The Advanced Warfighting Experiment Series

CAPT Ken Pankratz, MAJ John Larsen, LTC Stan Ritter
TRADOC Analysis Center
TRAC-WSMR
ATTN: ATRC-WJA
Capt Ken Pankratz
WSMR NM 88002

Approved abstract not available at printing.

WG 5 — EXPEDITIONARY WARFARE / POWER PROJECTION ASHORE — Agenda

Chair: Tim Sullivan, Texas Instruments, Inc.
Cochair: CDR "Boots" Barnes, OPNAV/N815
Advisor: Frank Kammel, NSWC
Room: GIF, 351-A

Tuesday 1030-1200
COMPOSITE GROUP II SESSION .... GIF, Dupuy Auditorium

Keynote Address: **RADM T.B. Fargo**, Director, Assessment Division, Navy Staff (Navy Sponsor)

Panel Discussion - ***Analyzing Data: Developing Concise Answers for the Senior Military Officer***
RADM T.B. Fargo, Moderator with analysts from the Navy Staff's Programming & Assessment Divisions, MCCDC's Studies & Analysis Division, HQMC's Program & Resources Division, OSD's PA&E Division, CNA and JHU/APL invited

Tuesday 1530-1700
AEGIS Performance During TOMAHAWK and NATO Air Strikes into BOSNIA-Herzegovina on 10 September 1995
Mr. Jeffrey McManus, Naval Surface Warfare Center, Dahlgren Division

Littoral Surveillance
CAPT Hank Bress and Dr. Tom ap Rhys, Naval Research Laboratory

Wednesday 0830-1000
JOINT SESSION, WG 5 & 6 .... GIF, Room 351 A & C

2005 Lesser Regional Contingency-Sea Lines of Communication (LRC-SLOCs) / Major Regional Contingency (MRC) - East Campaign Analysis
Ms. Robbin Beall, Office of the CNO, Assessment & Affordability Branch [OPNAV (N812D)]

Wednesday 1330-1500
Joint Mission Area / Support Area (JMA/SA) Excursions to 2005 Lesser Regional Contingency-Sea Lines of Communication (LRC-SLOCs) / Major Regional Contingency (MRC) - East Campaign Analysis
Ms. Robbin Beall, [OPNAV (N812D)]; COL (R) Ted Smyth, Marine Corps Combat Development Command representative during study

Wednesday 1515 - 1645
New Lethal SEAD Capability for TAC Brawler
Ms. Joanne Heath, Texas Instruments, Inc.

Ps Determination in Multi-Target/Massive Database Environment Using the SUPPRESSOR Simulation Model
Ms. Julie Wells, Texas Instruments, Inc.

The Owl™ MK II in the Arabian Gulf, Past and Current Littoral Operation in Mine Hunting and Acoustic Reconnaissance
Mr. Joseph S. Johnson, Space and Naval Warfare Systems Command

Thursday 0830-1000
JOINT SESSION, WG 5 & 6 .... GIF, Room 351 A & C

21st Century Combatant Force Architecture Study, An Overview
Mr. Michael Lindemann, Naval Surface Warfare Center, Dahlgren Division

Force Capability, Levels and Affordability. A Methodology for Assessing Force Investment Options
Mr. Eric Rocholl, Naval Surface Warfare Center, Dahlgren Division

Maneuver or Manoeuver Warfare for the U.S. Navy
Dr. Jim Tritten, U.S. Atlantic Command

Thursday 1330-1500
Effects of Anti-Armor Weapons in a Joint Warfare Campaign
Mr. Cliff Perrin, McDonnell Douglas Aerospace

A Methodology / Approach to Evaluate the Impact of Advanced Technology on Force Planning and Future Military Requirements
Ms. Janice Gess, Naval Air Warfare Center, Air Division

WG 5 — EXPEDITIONARY WARFARE / POWER PROJECTION ASHORE — Abstracts

Tuesday 1030-1200
COMPOSITE GROUP II SESSION
GIF, Dupuy Auditorium

Keynote address - By the navy Sponsor for MORS

RADM T.B. Fargo
Director, Assessment Division
2000 Navy Pentagon
Washington, D.C. 20350-2000
Phone: (703) 697-0831

Panel Discussion - ***Analyzing Data: Developing Concise Answers for the Senior Military Officer***

RADM T.B. Fargo - Moderator

In today's world of declining resources, it does not matter if it is detailed analysis or "spreadsheet" analysis, the available data must be deciphered, analyzed, and then developed into a clear presentation summarizing the results for the Boss. The Senior Officer or decision maker does not have time to review a significant amount of information; therefore, the final product must be concise.

Composite Group II's panel of analysts will discuss ideas for analyzing data and developing concise answers for the Senior Military Officer in today's fiscal environment. Participants on the panel include the Navy sponsor and analysts from the Navy Staff's Programming & Assessment Divisions; Marine Corps Combat Development Center's Studies & Analysis Division; Headquarters Marine Corps' Program & Resources Division; Office of the Secretary of Defense's Program Analysis and Evaluation Division; The Center for Naval Analyses; and the Johns Hopkins University Applied Physics Laboratory.

Tuesday 1530-1700
AEGIS Performance During TOMAHAWK and NATO Air Strikes into BOSNIA-Herzegovina on 10 September 1995

Mr. Jeffrey McManus
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Given the emphasis in joint littoral warfare, the ability to integrate multi-service weapon systems and coordinate air defenses is critical to future military success. More and more, the AEGIS Combat System is becoming a focal point in joint littoral operations.

Operation DELIBERATE FORCE in August - September 1995 consisted of strikes against Bosnian Serb positions in Bosnia-Herzegovina. The AEGIS cruisers USS *NORMANDY* (CG 60) and USS *MONTEREY* (CG 61) were part of the U.S. naval forces located in the Adriatic Sea that took part in the NATO operation. On 10 September 1995 *NORMANDY* launched thirteen TOMAHAWK missiles, and both *NORMANDY* and *MONTEREY* tracked the TOMAHAWK missiles and NATO air strikes into Bosnia.

This briefing will discuss the performance of the AEGIS Weapon System during the 10 September 1995 operations. Based on data collected from *NORMANDY* and *MONTEREY*, impacts of the littoral environment and joint datalink interoperability will be addressed. The ability of AEGIS to provide tactical situational awareness for operational command and control will also be discussed. Finally, lessons learned from this analysis pertaining to possible areas for improvement are identified and will be discussed in terms of future AEGIS upgrades.

Littoral Surveillance

CAPT Hank Bress and Dr. Tom ap Rhys
Naval Research Laboratory
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Littoral operations present some new and serious challenges to carrier-based systems in the detection and classification of the wide range of threats predicted to be in the littoral environment. A scheme is presented which involves the use of existing carrier-based assets and exploiting ongoing technological developments. From the results of the field evaluations of the two distinctive radars which form the core of this scheme, it is deduced that these challenges can be accepted and the required capability acquired quickly and economically.

Wednesday 0830-1000
JOINT SESSION, WG 5 & 6 . . . . GIF, Room 351 A & C

2005 Lesser Regional Contingency-Sea Lines of Communication (LRC-SLOCs) / Major Regional Contingency (MRC) - East Campaign Analysis

Ms. Robbin Beall
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A Persian Gulf conflict was analyzed form the Joint perspective with a spotlight on Naval forces. The scenario was based on a combination of two approved Defense Planning Guidance (DPG) based Naval Planning Scenarios (NPS). The study objectives were to show the impact of Naval forces on the land war, provide a campaign analysis baseline for excursions, and to illuminate Investment Balance Review (IBR) issues. The goal was to assess campaign outcomes and how Blue forces effected the outcome of the conflict. Warfighting effectiveness was measured in terms of force generation / access to theater, Blue losses, and ground war results.

Various modeling tools including Battlespace Dominance / Logistics models, Integrated Theater Engagement Model (ITEM) and TACWAR were used to assess sea, undersea, and air operations, including air-to-ground systems, at a suitable level of resolution to determine programmatic payoffs. TACWAR and ITEM were integrated for the first time.

This briefing will describe the baseline results. The presentation will also address the "lessons learned" as a result of integration of diverse models in the analysis and how technology is being applied to automate the process for future analyses. The product represents the work of the N812D staff and SPA, SAIC, APL contractor personnel.

Wednesday 1330-1500

Joint Mission Area / Support Area (JMA/SA) Excursions to 2005 Lesser Regional Contingency-Sea Lines of Communication (LRC-SLOCs) / Major Regional Contingency (MRC) - East Campaign Analysis

Ms. Robin Beall
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COL (R) Ted Smyth, MCCDC
Quantico, VA
JHU/APL: Phone (410) 792-6342

(Marine Corps Combat Development Command representative during study)

JMA/SA sponsored excursions to the LRC(SLOC) / MRC(E) baseline campaign analysis were assessed. The excursions addressed Amphibious Warfare (AMW), Naval Surface Fire Support (NSFS), Mine Counter Mine (MCM), arsenal ship, Theater Ballistic Missile Defense (TBMD), STRIKE, and opposed MCM issues. The excursions were defined as follows: (1) AMW - Advanced Amphibious Assault Vehicle (AAAV), V-22, and lightweight 155 mm Howitzer, (2) NSFS - improved naval guns and addition of Vertical Launching System (VLS) missile options, (3) MCM - Remote Minehunting System (RMS) and Long-Term Mine Reconnaissance (LMRS) plus upgrade to mine breaching system, (4) arsenal ship - impact to the halting phase, (5) TBMD - impact of Navy AEGIS with Theater High Altitude Air Defense (THAAD) airlift eliminated, (6) STRIKE - increased inventory of Joint Standoff Weapon - Sensor Fused Weapon (JSOW-SFW) and decreased inventory of Tomahawk Land Attack Missile (TLAM) inventory, and (7) opposed MCM - coordinated multiforce attack on Blue MCM forces. The impact of the excursions on the warfighting effectiveness was measured in terms of force generation / access to theater, Blue losses, and ground war results.

This briefing will describe excursion assessment results. The product represents the work of the N812D staff and SPA, SAIC, APL contractor personnel.

Wednesday 1515 - 1645

New Lethal SEAD Capability for TAC Brawler

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This paper presents the results of incorporating a Lethal SEAD capability into the TAC Brawler simulation by Texas Instruments & DSA. The presentation demonstrates the versatility of the TAC Brawler simulation to model an air-to-surface mission, a role that this model has not previously undertaken.

The requirement for this effort was to add an air-to-surface capability to the TAC Brawler simulation model to be able to focus on not only air-to-air warfare, but also to investigate the ability of an aircraft to perform a SEAD mission. Two surface-to-air missile systems were created in TAC Brawler to provide the threat. Generic guidance and acquisition algorithms were written and/or modified to model the flight trajectory and air-to-surface missile characteristics.

The culmination of this effort provided a SEAD capability in TAC Brawler. A video graphics demonstration will display the results of adding this new capability to the TAC Brawler simulation.

Ps Determination in Multi-Target/Massive Database Environment Using the SUPPRESSOR Simulation Model

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The intent of this paper is to present to MORS (Military Operations Research Society) a methodology for modeling an m-on-n (large threat laydown versus varying target types at many locations) scenario to determine the mission impact. Mission impact is illustrated via MOEs such as Probability of Survival (Ps). This presentation will not reflect on the explicits associated with any Texas Instruments program.

The presentation will concentrate on implementing the "Ops Analysis" methodology rather than concentrating on the answer. To illustrate our methodology reasonableness, we will use a "notional" mission impact end result.

An automated process was developed to create the SUPPRESSOR database input files that incorporated flight profiles with launch points, waypoints, and target location. A FORTRAN routine was developed to read in this data for each target, and create the SUPPRESSOR database player blocks.

In addition, a post processing routine was developed in C to combine the analysis database outputs to calculate average Ps for the target sets and confidence intervals around the mean for each target location. Finally, an Excel spreadsheet was created in order to categorize Ps results by target location, target type, flight profile, and sortie.

This presentation will discuss the SUPPRESSOR modeling decisions, data organization, analysis tools developed and some notional results.

The Owl™ MK II in the Arabian Gulf, Past and Current Littoral Operation in Mine Hunting and Acoustic Reconnaissance

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Approved abstract not available at printing.

Thursday 0830-1000
JOINT SESSION, WG 5 & 6 .... GIF, Room 351 A & C

21st Century Combatant Force Architecture Study, An Overview

Mr. Michael Lindeman
Naval Surface Warfare Center, Dahlgren Division

Force Capability, Levels and Affordability. A Methodology for Assessing Force Investment Options

Mr. Eric Rocholl
Naval Surface Warfare Center, Dahlgren Division

Maneuver or Manoeuver Warfare for the U.S. Navy
Dr. Jim Tritten
U.S. Atlantic Command

Thursday 1330-1500
Effects of Anti-Armor Weapons in a Joint Warfare Campaign

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This analysis presents the results of a nearly simultaneous two theater campaign occurring beyond the turn of the century. The terrain, weather and opposing forces in each theater differ significantly, requiring different tactics, technologies and weapon systems to engage the enemy. The effects of using anti-armor submunition weapons; like Sensor Fused Weapon (SFW) and Brilliant Anti-armor Munition (BAT), when delivered from various platforms is investigated. The analysis uses a McDonnell Douglas aerospace developed tool; the Air, Land, Sea Warfare Analysis Tool (ALSWAT). All aspects of a Joint / Combined air, naval and ground warfare campaign are represented in ALSWAT.

What makes a difference in the outcome of a campaign is presented through troop movement, objectives achieved and battle timelines.

A Methodology / Approach to Evaluate the Impact of Advanced Technology on Force Planning and Future Military Requirements

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The current political environment has left some questions as to the steps that the U.S. military should take to prepare for future warfare. The U.S. military had been planning its operations against a strong Soviet Union military force for decades. With the disestablishment of the Soviet Union, a new perspective is required to be prepared for military confrontations. Overall, aside from the Soviet Union force, there are not many countries that have a strong military to compare to the United States. However, in spite of the current situation it is important to be prepared for potential problems in the future. Should the U.S. give up its unique position as the number one Super Power, opportunities for other countries to take advantage of U.S. weakness may produce unacceptable results to the U.S., its security, and its way of life. To be sure that this does not happen, it would benefit the U.S. and its military to be prepared for future warfare - to look at potential and possible options where military force may occur not just in the next five years, but also the next 10, 20, or 30 years.

In the Navy's R&D laboratory system, the Navy has developed methodologies to look at future warfare and has evaluated technology systems requirements that should be developed. However, in most situations the laboratories looked at technologies from a relatively narrow perspective (one mission area, a single threat), and did not consider the broad view of joint and combined warfare. Systems were compared within mission area but not against a total warfare perspective. This paper, in a total warfare context, proposes a methodology to review future warfare and evaluate proposed systems. At the same time, the methodology should be considered as a tool for (1) reviewing future warfare options, strategies and tactics, (2) training personnel at all levels to understand the impact of platform capabilities, platform interaction and strategies and tactics, and (3) communicating and articulating issues of warfare across mission areas, joint and combined campaign and multi-service requirements.

The methodology will be described with its associated measures of effectiveness. Criteria for evaluating the methodology will then be discussed. Issues relative to the application of the methodology will be reviewed and then overall conclusion and summaries will be made.

WG 6 — LITTORAL WARFARE AND REGIONAL SEA CONTROL — Agenda

Chair: CDR Kirk Michealson, OPNAV/N815
Cochair: Michael Cala, CNA
Cochair: Kirk Bretney, Hughes Aircraft Co.
Cochair: LCDR Jeff Cares, HQ UNC/ROK-US CFC/USFK
Advisor: Dr. Steve Pilnick, Global Associates, Ltd.
Room: GIF, 351-C

Tuesday, 1030-1200
COMPOSITE GROUP II SESSION .... GIF, Dupuy Auditorium

Keynote Address
RADM T. B. Fargo, Director, Assessment Division, Navy Staff (Navy Sponsor)

Panel Discussion - *Analyzing Data: Developing Concise Answers for the Senior Military Officer*
RADM T.B. Fargo, Moderator with analysts from the Navy Staff's Programming & Assessment Divisions, MCCDC's Studies & Analysis Division, HQMC's Program & Resources Division, OSD's PA&E Division, CNA and JHU/APL invited

Tuesday, 1530-1700: TECHNOLOGY FOR LITTORAL WARFARE
Composite Industry View of Application of Technology to Littoral Warfare
Mr. Milton Gussow, The Johns Hopkins University Applied Physics Laboratory

Advanced Deployable System (ADS)
CDR John Curtis, Office of the CNO,Undersea Surveillance/Deployed Systems Division [OPNAV (N874C)]

Design, Cost and Effectiveness Impacts of Surface Combatant Topside Signature Reduction in Littoral Environments
Mr. James King & Mr. Daniel Platt, Naval Surface Warfare Center, Carderock Division

Wednesday, 0830-1000
JOINT SESSION, WG 5 & 6 .... GIF, Room 351 A & C

Joint/Combined Warfighting Analysis
Ms. Robbin Beall, Office of the CNO, Campaign Analysis Branch, Assessment Division [OPNAV (N812D)]

Wednesday, 1330-1500: AMPHIBIOUS & MINE WARFARE IN THE LITTORALS
Integrated Amphibious and Mine Warfare Operational Concept for the Year 2010
Mr. Andrew Fosina, LOGICON-Syscon

Modeling a Swarming Approach to Mine Countermeasures in an Amphibious Assault
LT Tim Weber, Prof. Bard Mansager & Prof. Carlos Borges, Naval Postgraduate School

Naval Surface Fire Support Architecture Study
Mr. Greg Latta, Hughes Missile System Company

Wednesday, 1515 - 1645: AEGIS PERFORMANCE AND CEC IN THE LITTORALS
AEGIS Performance During TOMAHAWK and NATO Air Strikes into Bosnia-Herzegovina on 10 September 1995
Mr. Jeffrey McManus, Naval Surface Warfare Center, Dahlgren Division

Joint Engagement Technology Study (JETS) with DIS Network
Mr. William Williams & Mr. George Cherolis, BDM Engineering Services Company

Thursday, 0830-1000
JOINT SESSION, WG 5 & 6 .... GIF, Room 351 A & C

21st Century Surface Combatant Force Architecture Assessment, An Overview
Mr. Michael Lindemann, Naval Surface Warfare Center, Dahlgren Division

Force Capability, Levels and Affordability, A Methodology for Assessing Force Investment Options
Mr. Eric Rochell, Naval Surface Warfare Center, Dahlgren Division

Maneuver or "Manoeuvre" Warfare for the U.S. Navy
Dr. James Tritten, U.S. Atlantic Command

Thursday, 1330-1500 : INVENTORY ASSESSMENTS: SURFACE FORCE CAPABILITIES AND TORPEDO REQUIREMENTS
Sufficiency Analysis, Measuring Surface Force Capability Requirements
Mr. Michael Morris, The Johns Hopkins University Applied Physics Laboratory

Future Surface Combatant Capabilities
LCDR Jeffrey Cares, HQ CINC UNC/ROK-US CFC/USFK, Operations Analysis Branch

Lightweight Torpedo Inventory Requirements
Dr. Steven Pilnick, Global Associates, Ltd.

WG 6 — LITTORAL WARFARE AND REGIONAL SEA CONTROL — Alternates

The OWL™ MK II in the Arabian Gulf, Past and Current Littoral Operations in Mine Hunting and Acoustic Reconnaissance
Mr. Joe Johnson, SPAWAR

WG 6 — LITTORAL WARFARE AND REGIONAL SEA CONTROL — Abstracts

Tuesday, 1030-1200
COMPOSITE GROUP II SESSION
GIF, Dupuy Auditorium

Keynote Address - By the Navy Sponsor for MORS

RADM T. B. Fargo
Director, Assessment Division
2000 Navy Pentagon
Washington, D.C. 20350-2000

Panel Discussion - ***Analyzing Data: Developing Concise Answers for the Senior Military Officer***

RADM T. B. Fargo - Moderator

In today's world of declining resources, it does not matter if it is detailed analysis or "spreadsheet" analysis, the available data must be deciphered, analyzed, and then developed into a clear presentation summarizing the results for the Boss. The Senior Officer or decision maker does not have the time to review a significant amount of information; therefore, the final product must be concise.

Composite Group II's Panel of analysts will discuss ideas for analyzing data and developing concise answers for the Senior Military Officer in today's fiscal environment. Participants on the panel include the Navy sponsor and analysts from the Navy Staff's Programming & Assessment Divisions; Marine Corps Combat Development Center's Studies & Analysis Division; Headquarters Marine Corps' Programs & Resources Division; the Office of the Secretary of Defense's Program Analysis & Evaluation Division; the Center for Naval Analyses; and the Johns Hopkins University Applied Physics Laboratory.

Tuesday, 1530-1700 : TECHNOLOGY FOR LITTORAL WARFARE
Composite Industry View of Application of Technology to Littoral Warfare

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During 1993 and 1994 the defense industry conducted a study on the application of technology in support of littoral warfare in response to tasking by the DCNO for Resources, Warfare Requirements and Assessments (N8). VADM Owens, then N8, challenged industry to help the Navy toward achieving warfighting capability needed to sustain it in the 21st century. He advised industry to think imaginatively on how to protect naval assets in littoral warfare from stealthy, low-flying cruise missiles as well as from Theater Ballistic Missiles. A report was prepared and presented to the N8 staff in 1995. This presentation is a summary of that report. It will describe the opportunities for development and application of new technologies which emerged from considering 14 different tactical situations that may occur in the prosecution of joint littoral warfare. The technology opportunities are grouped into three technology areas: missile/gun/ordnance, surveillance and countermeasures. The description of technology applications was deliberately generic and thus not related to any specific system or subsystem. No consensus was reached nor attempted by industry to identify that advancement of one technology is more important than another in enhancing naval warfighting capabilities.

Advanced Deployable System (ADS)

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The success of modern land war scenarios involving both major or lesser regional conflicts are heavily dependent upon the ability to insert and re-supply land forces "from the sea". The majority of these contingency situations are considered Littoral Warfare scenarios. As such, the sea lanes of communication (SLOC) which deliver over 90% of all material to the conflict area, pass through shallow waters where they are extremely vulnerable to submarines.

The shallow water diesel submarine threat draws much attention due to the proliferation of very lethal and difficult to detect platforms in several third world countries. Additionally, sophisticated, stealthy mines will likely oppose our Naval forces in what is usually a very noisy shallow water environment.

In these situations, the Joint Task Force Commander (JTFC) requires the ability to conduct high confidence, wide area undersea surveillance to detect and track very quiet submarines and monitor enemy mine laying operations. To this end, ADS is being developed to detect, localize and track these threats.

The ADS Cost and Operational Effectiveness Analysis (COEA) indicates that ADS is the only cost effective solution to undersea surveillance where such actions encompass a few weeks to two years. ADS will be stored in theater and can be deployed on short notice to provide the JTFC unique intelligence which is unavailable from any other source. It will allow the JTFC to continuously surveil large areas with high confidence for threats which have the potential to prevent mission essential logistics from being delivered.

Design, Cost and Effectiveness Impacts of Surface Combatant Topside Signature Reduction in Littoral Environments

Mr. Daniel Platt, Naval Architect; and
Mr. James King, Head, Signature Control Technology Department
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Previous studies have examined the impact of controlled ship signatures on ship effectiveness. However, these studies emphasized the Global Warfare scenarios of concern during the Cold War and they examined the operational benefits of signature reduction largely parametrically. These studies, which demonstrated the value of signature reduction, needed to be updated.

The present study identifies those areas in which R&D investment has the greatest potential benefit by linking specific technologies to achievable signatures and to cost and effectiveness levels.

In this study, a family of ship concepts was developed that incorporated a variety of signature reduction technologies and combat systems. These concepts were then analyzed to determine (1) their radar and infrared signatures; (2) their procurement and life cycle costs; and (3) their operational effectiveness in performing a representative set of littoral-type missions against current and projected threats.

Concepts were developed using the Navy's ASSET ship design tool and signatures were evaluated using a variety of methods. Costs were estimated using two internal Navy cost estimating methods. Operational effectiveness studies were performed using, primarily, the Naval Air Battle Engagement Model.

The study resulted in clear direction for the development of future ship concepts and identified technology needs.

Wednesday, 0830-1000
JOINT SESSION, WG 5 & 6 . . . . GIF, Room 351 A & C

Joint/Combined Warfighting Analysis

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Approved abstract not available at printing.

Wednesday, 1330-1500 : AMPHIBIOUS & MINE WARFARE IN THE LITTORALS

Integrated Amphibious and Mine Warfare Operational Concept for the Year 2010

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The Navy's Exploratory Development Concept Program examines concepts which provide potential for breaching mines and obstacles in the surf zone and on the beach in support of amphibious operations in the year 2010. System engineers, analysts, and acquisition professionals must have a thorough understanding of the operational arena and employment techniques that are essential to these operations in the year 2010.

This report provides an integrated amphibious and mine warfare operational concept for the year 2010 within which shallow water mine countermeasures systems will be employed. The report presents an amphibious assault from over the horizon and incorporates operational maneuver from the sea. The operational concept is consistent with the requirements of the Navy's shallow water mine countermeasures mission needs statement and operational requirements document. Additionally, this operational concept is fully aligned with the Fleet Marine Force Reference Publication 14-25, "A Concept for Mine Countermeasures in Littoral Power Projection," and the recently published CNO (N852) "Concept of Operations for Mine Countermeasures in the 21st Century."

Modeling a Swarming Approach to Mine Countermeasures in an Amphibious Assault

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Prof. Carlos Borges
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Lemmings are autonomous tracked underwater vehicles which utilize a swarming approach to mine detection and neutralization in the very shallow water, surf, and beach zones. The Navy and the Marine Corps are in great need of developing an effective "in stride" clearance/breaching method to further enhance the effectiveness and viability of their littoral warfare capabilities. The Lemmings system has the potential to fulfill this critical need in a cost effective, reliable manner.

Utilizing the Janus interactive wargaming simulation, an amphibious operation was modeled with the landing taking place through a minefield in the very shallow water, surf zone, and beach zone. Three scenarios were developed:

- An amphibious landing through a minefield with no clearing/breaching
- An amphibious landing through a minefield with "traditional" current mine clearing, breaching capabilities
- An amphibious landing through a minefield utilizing the Lemmings system as the clearance/ breaching method

A comparative analysis of the three scenarios was performed, examining the measures of effectiveness of landing vehicles killed, time required to land the assault echelon, and the combat power ashore.

Naval Surface Fire Support Architecture Study

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Approved abstract not available at printing.

<u>*Wednesday, 1515 - 1645: AEGIS PERFORMANCE AND CEC IN THE LITTORALS*</u>

AEGIS Performance During TOMAHAWK and NATO Air Strikes into Bosnia-Herzegovina on 10 September 1995

Mr. Jeffrey McManus
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Given the emphasis in joint littoral warfare, the ability to integrate multi-service weapon systems and coordinate air defenses is critical to future military success. More and more the AEGIS Combat System is becoming a focal point in joint littoral operations.

Operation DELIBERATE FORCE in August-September 1995 consisted of strikes against Bosnian Serb positions in Bosnia-Herzegovina. The AEGIS cruisers USS NORMANDY (CG 60) and USS MONTEREY (CG 61) were part of U.S. naval forces located in the Adriatic Sea that took part in this NATO operation. On 10 September 1995, NORMANDY launched 13 TOMAHAWK missiles, and both NORMANDY and MONTEREY tracked the TOMAHAWK missiles and NATO air strikes into Bosnia.

This briefing will discuss the performance of the AEGIS Weapon System during the 10 September 1995 operations. Based on data collected from NORMANDY and MONTEREY, impacts of the littoral environment and joint datalink interoperability will be addressed. The ability of AEGIS to provide tactical situational awareness for operational command and control will also be discussed. Finally, lessons learned from this analysis pertaining to possible areas for improvement are identified and will be discussed in terms of future AEGIS upgrades.

Joint Engagement Technology Study (JETS) with DIS Network

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The Cooperative Engagement Capability (CEC) was developed by the Navy to use raw sensor track information from various ships and aircraft in a Navy battle group to derive an integrated air picture. This best derived air picture is then shared by all networked units. The improved accuracy and timeliness of the air picture provided by CEC allow a rapid and effective response to high-speed threats like cruise missiles and theater ballistic missiles. The Joint Engagement Technology Study (JETS) will investigate the impact of integrating naval air defense capabilities in a joint force air defense architecture by incorporating an AWACS with CEC into a naval battle group network. The primary means for tactical information exchange will be Link-16 and the Tactical Information Broadcast System.

This presentation will cover the establishment of the extensive distributed simulation architecture and data collection needed for JETS. This distributed simulation network will include:

- the Naval Command, Control and Ocean Surveillance Center RDT&E Division;
- the Tactical Air Command and Control Simulation Facility;
- the Theater Battle Arena; and
- the Boeing Space and Defense Division.

DIS 2.04 protocols will be used to integrate simulations from the above facilities to create a virtual Joint warfare environment. Within this environment various air defense scenarios will be used to measure the performance of a Joint force using alternative capabilities (AWACS without and with CEC) in conducting air defense operations.

Thursday, 0830-1000
JOINT SESSION, WG 5 & 6 . . . . GIF, Room 351 A & C

21st Century Surface Combatant Force Architecture Assessment, An Overview

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This paper discusses the background, analysis process and the results of an OPNAV N86 study to determine long term needs for a surface combatant force. It was conducted in preparation of the acquisition of the 21st Century Surface Combatant (SC-21) and the Milestone I COEA. Surface force requirements are developed and surface force capability, force levels and overall affordability measured against these force requirements. Candidate ship concepts addressing shortfalls are proposed and evaluated in the context of force capability, levels and affordability. The dynamics of the three parameters are examined over a 35 year period as the surface force evolves under various investment strategies. Several strategies are identified as meeting requirements at affordable levels.

Force Capability, Levels and Affordability, A Methodology for Assessing Force Investment Options

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This paper describes the methodology developed for the 21st Century Surface Combatant Force Architecture Assessment to describe and trade off the three principal parameters of the study: force capability, force levels, and affordability, using sufficiency analysis results as the requirement basis. Investment options identified annual procurement levels and modernization plans of various class ships. Various investment options are defined to satisfy force requirements. The three parameters are tracked over time for various investment options as the complexion of the force evolves. Ship procurements, modernization and retirements are considered as they affect force capability and levels over time. The investment option results of the SC-21 Force Architecture Assessment are highlighted.

***Maneuver or "Manoeuvre"* Warfare for the U.S. Navy**

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Initial report on the theory of "maneuver" warfare in the deep ocean environment. Author's thesis is that Navy officers have had over ten years of exposure to literature on ground and sea-shore concepts of "maneuver" warfare but that it has not yet taken firm hold. In order to allow the Navy to be an equal participant in the development of "maneuver" warfare doctrine, this concept will have to be explained in terms familiar to the majority of navy officers -- open ocean "maneuver" not associated with sea-shore "maneuver." Report opens with history of the concept of "maneuver" and an analysis of how current juxtapositions with attrition are inaccurate. A more correct reading of history is that warfare is either attrition (over time) or annihilation (quick). "Maneuver" warfare fits into either. An initial theory of Navy manoeuvre warfare doctrine is developed using classical Italian, Russian, German, Chinese, Japanese, and French materials. Of specific note is the earlier work of French Admiral Raoul Castex in the areas of *manoeuvre* at the operational level of war. Report ends with a vision of a future battlespace in which "maneuver"/*manoeuvre* warfare is the primary doctrine for naval forces. The report is the first in a series which will explore the concept.

Thursday, 1330-1500: INVENTORY ASSESSMENTS: SURFACE FORCE CAPABILITIES AND TORPEDO REQUIREMENTS

Sufficiency Analysis, Measuring Surface Force Capability Requirements

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This paper presents a straightforward methodology for determining the required capability of naval forces and the application of the methodology to the recently completed 21st Century Surface Combatant Force Architecture Assessment. Capability is defined in terms of individual ship mission capability and the composite capability of a group of ships required to execute specific tasks. Force level capability is measured in terms of numbers of ships of various classes. Requirements are computed as a function of the changing warfighting needs throughout a regional conflict campaign. The methodology is applied to determine long term surface navy requirements and the value of different mixes of ship types or classes.

Future Surface Combatant Capabilities

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Recent developments in modern naval combat theory offer new insights to the configuration, capabilities mix, and force structure of surface combatants. This paper reviews the theoretical constructs of modern naval combat theory and uses the theory to describe characteristics of future surface combatants.

This paper begins with a discussion of two equations which dominate analysis of surface combatant characteristics: the *salvo attrition equation* and the *salvo exchange set*. These event-stepped relations replace Lanchesterian time-stepped attrition equations (which described combat before the advent of missile

exchanges). The salvo attrition equation defines the relationship between offensive combat power and active and passive defenses. The salvo exchange set describes the different possible outcomes of salvo exchanges as defined by the salvo attrition equation.

The paper next describes four surface combatant missions: *offensive naval attack, power projection, defensive naval combat,* and *general* missions. If force planners had unlimited resources, they would simply build a full range of capabilities into every ship. Cost and technology, however, are constraints. The salvo attrition equation and the salvo exchange set show trade-offs between characteristics, thereby providing cost comparisons between capabilities or defining the value of a future technology.

Subsequently, the paper describes other capability considerations: decreasing returns to scale for seduction decoys, the strategic value of staying power, the value of area defense, combat media trade-offs, and relationships between quantity and capability. The paper concludes by describing desirable qualities of the following surface combatant capabilities: scouting effectiveness, manpower, offensive combat power, defensive combat power, decoy effectiveness, and staying power.

Lightweight Torpedo Inventory Requirements

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The U.S. Navy tasked an independent study to determine the proper and reasonable lightweight torpedo inventory requirement for surface and air platforms. The assessment was directed, as a minimum, to take into account ship fill, platform firing capabilities, weapon capabilities, and estimated scenarios and threats projected through the year 2010. The study analytically reviews existing requirements, the Non-Nuclear Ordnance Requirements (NNOR) process, data and lessons learned from SHAREM (Ship and Helicopter ASW Readiness Effectiveness Measurement) exercises, Naval Undersea Warfare Center torpedo testing data, current logistics data, scenarios derived from the Defense Planning Guidance, and recent wargame analysis. Proposed lightweight torpedo inventory requirements are developed following the Capabilities Based Munitions Requirements (CBMR) paradigm (as does NNOR). A new model is developed for combat expenditures, separating ASW false attacks from threat attrition expenditures. The resulting proposed requirements are checked for robustness by comparison with other models and scenarios. Sensitivity analysis is performed to examine the effect of variation of model input parameters and assumptions.

WG 6 - LITTORAL WARFARE AND REGIONAL SEA CONTROL - Alternate

The OWL™ MK II in the Arabian Gulf, Past and Current Littoral Operation in Mine Hunting and Acoustic Reconnaissance

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Approved abstract not available at printing.

WG 7 — NUCLEAR, BIOLOGICAL, AND CHEMICAL DEFENSE — Agenda

Chair: MAJ Jerry A. Glasow, Secretariat to the Joint NBC Defense Board
CoChair: Rob Kehlet, Defense Nuclear Agency
CoChair: Mike Kierzewski, Optimetrics, Inc.
Advisor: Doug Schultz, Institute for Defense Analyses
Room: GIF, 352-D

Tuesday, 1030-1200
Chemical/Biological Modeling and Simulation Process Action Team (CBMS PAT)
MAJ Jerry A. Glasow, Secretariat to the Joint NBC Defense Board

Chemical Biological Information Network (CBINFONET)
Julia Taylor, Joint Contact Point, US Army Dugway Proving Ground

The Application of Group Interactive Decision Support Techniques to Define Naval Aviation Chemical & Biological (CB) Survivability Requirements
Eric Adcock, Battelle Memorial Institute

Tuesday, 1530-1700
Hazard from Industrial Chemicals
Chuck Crawford, Edgewood Research, Development, and Engineering Center (ERDEC)

Defense Nuclear Agency (DNA) - Federal Emergency Management Agency (FEMA) Tool for Disaster Assessment as Applied to NBC Incidents
Rob Kehlet, Defense Nuclear Agency

Value-Added Model Development, V&V, and Analysis
Ray Jablonski, Edgewood Research, Development, and Engineering Center (ERDEC)

Wednesday, 0830-1000
Operational Analysis of the Long Range Biological Standoff Detection System
Doug Schultz, Institute for Defense Analyses

Wednesday, 1330-1500 - **COMPOSITE GROUP III SESSION** .... **Bell Hall, Marshall Auditorium**

Wednesday, 1515 - 1645
M40 Series Protective Mask Effectiveness Against Anthrax
MAJ Jerry A. Glasow, Secretariat to the Joint NBC Defense Board

Validating Human Response Phenomenology (30 min)
Arthur Deverill, ARES Corporation

Establishing Criteria and Methodology of CB Related Low-Dose Responses
Ray Jablonshi, Edgewood Research, Development, and Engineering Center (ERDEC)

Thursday, 0830-1000
Working Session - Utility of Detailed Hazard Predictions in an Operational Scenario (90 min)
Mike Kierzewski, Optimetrics, Inc.

Thursday, 1330-1500
Chemical Warfare Attack Effects on FFG Class Ships (30 min)
Tom Yencha, Naval Surface Warfare Center

Effectiveness of Tactical Ballistic Missiles against Military Targets (30 min)
David McGarvey, RAND

Integrated Conventional and Chemical Analysis of a Major Regional Contingency (30 min)
Ian M. Snyder, BDM Federal, Inc.

WG 7 - NBC Defense Working Group - Alternate - ***Crusader Challenge Level Analysis***
Mr. Ray Jablonski, GS-12, Operations Research Analyst

WG 7 — NUCLEAR, BIOLOGICAL, AND CHEMICAL DEFENSE — Abstracts

Tuesday, 1030-1200
Chemical/Biological Modeling and Simulation Process Action Team (CBMS PAT)

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The Assistant Secretary of Defense for Nuclear. Chemical and Biological, Chemical-Biological Matters, ATSD(NCB)(CBM). and the Deputy Under Secretary of the Army for Operations Research, DUSA(OR), established the CBMS PAT to evaluate modeling efforts and to provide OSD in its oversight role and the Army in its NBC RDA DOD Executive Agency role, with means to better coordinate DOD CB modeling and simulation. The long term goal of OSD and the Army is to institutionalize processes and procedures to improve the management of CB modeling and simulation work. The PAT consists of an Umbrella Group and two subgroups. The Umbrella Group reviews and approves the work of the Requirements Subgroup and the Modeling Subgroup. The Requirements Subgroup is responsible for the identification of operational requirements for models, for making recommendations on the prioritization of the requirements, and developing processes and procedures for conducting future reviews of CB modeling requirements. The Modeling Subgroup is responsible for identifying CB-related models and their associated data requirements. The Modeling Subgroup will make recommendations if unique VVA needs exist for CB models and recommendations for engineering-level models needed to provide direct inputs to force-on-force models. The objective of this effort is to evaluate current modeling efforts and to provide OSD with a coordinated and integrated CB modeling program, where possible harmonizing individual Service and Agency work into joint programs, eliminating duplication of effort and overlapping projects, and ensuring that valid CB modeling requirements are being addressed. This effort addresses Service and Agency CB modeling; modeling used in CB simulations and wargaming efforts; and related data collection and archiving.

Chemical Biological Information Network (CBINFONET)

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Dugway Proving Ground operates the Joint Technical Information Center (JTIC) which has more than 70,000 documents dealing with chemical and biological warfare defense information. The collection dates from the early 1940s and includes documents from Fort Detrick, Deseret Test Center, and Panama Test Center. We have developed a chemical/biological information network, CBINFONET, which consists of two on-line databases: Bibliographic Research Service which contains document abstracts and the Document Image Database which consists of computer imaged documents. JTIC is the first fully automated technical library available in the US Army. Both the catalog of and the images of selected documents are available through a supporting computer network. The unclassified information is available both at Dugway Proving Ground and anywhere there is an appropriately configured PC. Authorized customers access a computer based document catalog and abstract system to find needed, referenced documents. Documents can be found by title, author, subject, or key words. After the documents are located in the electronic catalog, the customer can type into the networked PC the reference number of that document. An image of the document appears at the individual's PC. The individual can review and/or print pages from the document at his or her workstation. Customers access both the catalog and the image system through the Department of Defense's portion of Internet. The catalog is available nationwide from the deserts of Yuma Proving Ground in Arizona to various locations in the Pentagon. The image viewing capability is available within Dugway Proving Ground. We are developing a "quick install" package to enable current catalog users outside of Dugway to access the imaging system. This will provide easy access to chemical and biological data for the military analyst.

The Application of Group-Interactive Decision Support Techniques to Define Naval Aviation Chemical & Biological (CB) Survivability Requirements

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With the shift in emphasis to littoral operations, the likelihood of U.S. Naval Aviation forces encountering a CB threat in future conflicts has significantly increased. Naval Aviation is required to carry out its vast array of missions with inconsequential degradation of operational capability in a CB threat environment. This paper describes how the Navy has inserted information technology into the decision making process for fulfilling this requirement. In supporting development of aviation CB defense (CBD) requirements, the Chief of Naval Operations staffed a Mission Need Statement (MNS) for Naval Aviation CB Warfare Survivability in the second quarter of FY95. In response, Naval Air Systems Command (NAVAIR) and the Office of Naval Research (ONR) developed a Master Plan which further defines CBD needs stated in the MNS and provides a roadmap for meeting those needs. Given limited resources and schedule objectives, NAVAIR and ONR applied a variety of group-interactive decision support techniques to accomplish this task. Electronic Meeting Support systems were used during a series of Fleet Operator Focus

Group Workshops to efficiently and simultaneously obtain technical and operational input from Fleet operators, scientific experts, and acquisition managers on aviation CBD deficiencies and requirements. Current capabilities and shortfalls were assessed and compared with projected future capabilities to identify gaps and to support future planning and development. Additional management science tools such as the Analytical Hierarchy Process and Pareto Optimization are now being used to prioritize CBD deficiencies and determine optimum resource allocation strategies.

Tuesday, 1530-1700
Hazard from Industrial Chemicals

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It cannot be denied that forces may encounter toxic industrial chemical in their military missions throughout the world. This presentation will review a recent study, and the criteria that were developed, to determine whether there is a threat from the release of industrial chemicals in a military situation. Chemical of concern are identified and hazard management (detection, protection, and operations) will be discussed.

All Hazard Situation Assessment Program (ASAP) - Consequence Assessment Tool Set (CATS)

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Responding to the lack of timely, effective Federal Relief support following Hurricane Andrew, the Defense Nuclear Agency (DNA) and the Federal Emergency Management Agency (FEMA) initiated the All-Hazards Situation Assessment Program (ASAP) in January, 1993, to address hazard damage estimation and resource planning for natural disasters. Since the beginning of 1995, the ASAP has been expanded to assume a larger role in disaster relief support within the Department of Defense (DOD). The latest version has been renamed the Consequence Assessment Tool Set (CATS) for its ability to address the hazards and consequences from both technological and natural disasters. CATS is a computer system that models the hazards caused by the disaster and integrates them with diverse databases in a high-end geographic information system (GIS). This combination of modules allows emergency managers to assess the consequences of the disaster in near-real time and thereby determine relief support requirements. CATS has imbedded physical models which define the conditions caused by hurricanes, storm surge, earthquakes, floods, chemical, and reactor releases, and terrorist-like chemical/biological actions. Levels of structural and personnel vulnerability criteria are combined with the hazard conditions to determine areas at risk. Consequences of the disaster are determined by intersecting the areas at risk with diverse population, facility, resource, and infrastructure databases. With this information, the emergency managers can quickly allocate appropriate relief support materiel and personnel to the area. The program has been pressed into used to support emergency response for the 1993 Mid-West floods, Hurricanes Emily, Alison, Luis, Marilyn, and Opal; the Northridge earthquake, and the Georgia, Florida, and Texas floods.

Value-Added Model Development, V&V, and Analysis

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Approved abstract not available at printing.

Wednesday, 0830-1000
Operational Analysis of the Long Range Biological Standoff Detection System

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This briefing will provide an overview and results of the operational analysis of the Long Range Biological Standoff Detection System (LRBSDS). The LRBSDS is a LIDAR (light detection and ranging) board particle detector mounted in a UH-60 Black Hawk. The system is designed to detect and map large clouds of particular matter and provide generic biological agent detection. The analysis addresses the tactics employed by the detection system and the sensitivity of the device to various combinations of detector sensitivity and atmospheric viability. The combinations of tactics, sensitivity and visibility are examined against four potential biological agents, anthrax, plague, botulinum toxin and staphylococcus enterotoxin.

Wednesday, 1330-1500 - **COMPOSITE GROUP III SESSION**
Bell Hall, Marshall Auditorium

Wednesday, 1515 - 1645
M40 Series Protective Mask Effectiveness Against Anthrax

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The US Army Chemical Schoolls (CMLS) Protective Mask Requirements Analysis, 1 Oct 86, established a DUSA(OR)

approved procedure to link protective mask production standards to an acceptable operational risk standard for chemical agents. This chemical agent operational risk standard is less than 1% lethalities or requiring medical care and less than 15% myosis effects for a specified chemical attack scenario (1%/15% standard). The analysis made no attempt to set a standard for biological agents. I repeated the CMLS analysis for a typical anthrax attack as depicted using the Naval Surface Warfare Centerls VLSTRACK hazard prediction model. Instead of using the Protection Factor (PF) distribution assumed in the original analysis, I used the actual PF distribution now available from corn oil chamber tests. Using the generally accepted LD50 for anthrax, total casualties were calculated to be 0.003% (3 per 100,000). Assuming an order of magnitude greater lethality for the LD50, total casualties came out at 0.147% (147 per 100,000). This analysis, like the original analysis, assumes soldiers wore their masks during the entire duration of the inhalation hazard. The primary driver for these low casualty rates is the quality of the M40 series mask when used in conjunction with fit testing using the M41 Protection Assessment Test Set (PATS).

Validating Human Response Phenomenology

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A well recognized shortcoming in combat models is the lack of human performance stressor response data. Because it is unethical to expose military personnel to NBC weapons effects stressors, DNA has sponsored a series of studies for employing and validating surrogate means to provide combat models with the capability to represent the time dependent human performance degradation as well as the operational casualties resulting from conducting sustained operations in an NBC environment. This presentation compares the measured performance of selected M198 howitzer crew tasks in the full MOPP4 personal protective ensemble with Subject Matter Experts' (SMEs') estimates of performance of analogous tasks after various times in MOPP4, obtained using a structured questionnaire methodology. The analyses reported here take advantage of a rare opportunity to gather measured data and SME questionnaire estimation data on changes in task performance from the same military personnel under real-world NBC environment stressor conditions .

Establishing Criteria and Methodology of CB Related Low-Dose Responses

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Approved abstract not available at printing.

Thursday, 0830-1000

Utility of Detailed Hazard Predictions in an Operational Scenario

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Approved abstract not available at printing.

Thursday, 1330-1500

Chemical Warfare Attack Effects on FFG Class Ships

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Approved abstract not available at printing.

Effectiveness of Chemical Theater Ballistic Missiles Against Military Targets

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Theater ballistic missiles (TBMs) with chemical payloads could be enormously destructive if used against concentrations of population. Less well understood is their potential effectiveness against military targets and the resulting implications for defense. The paper presents a parametric analysis of the requirements to achieve specified levels of effectiveness against area military targets and notes significant differences between the problem of designing a counter-military as distinct from a counter-civilian attacks: (1) Whereas the immediate purpose of a TBM attack against civilians would probably be to inflict casualties in a relatively unprotected population, the immediate purpose of a TBM attack against a well-equipped and trained military would more likely be to disrupt operations for as long as possible, which would affect the choice of chemical agent used. (2) The interplay among wind uncertainly, TBM accuracy, submunition dispersion pattern, height of burst, and resulting target coverage are substantially different for attacks against cities than for attacks against typical military installations. As a consequence, under typical conditions of uncertainty in wind, unitary warheads can be as effective as or substantially more effective than submunition payloads against large area targets such as cities, but are substantially less effective against military targets. Other consequences of design considerations are presented in the paper. The paper notes wide disparities in points of view on the military effectiveness of TBMs with chemical payloads and discusses prospects for resolving these disparities.

Integrated Conventional and Chemical Analysis of a Major Regional Contingency

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Approved abstract not available at printing.

WG 7 - NBC Defense Working Group - Alternate
Crusader Challenge Level Analysis

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Approved abstract not available at printing.

WG 8 — MOBILITY — Agenda

Chair: Denis Clements, JWARS Office (OSD,PA&E)
Cochairs: Tom Denesia, USTRANSCOM/J5-AA
Frank McKie, USA CAA/CSCA-MD
Jim Hill, McDonnell Douglas Corp
LtCol Daniel Briand, AFSAA
Room: GIF, 354-C

Tuesday, 1030-1200
Airlift Sealift Cycle Analysis Model
Mr. Thomas E. Denesia, USTRANSCOM/J5-AA

Strategic Sealift Analysis System
Mr. Robert G. Elwell, Commander, Military Sealift Command

Optimization of the Air Mobility System
Professor Richard E. Rosenthal, PhD, Operations Research Department Naval Postgraduate School

Tuesday, 1530-1700
Analysis of the Impact of Terrain Resolution on Modeling and Simulation Outcomes
Ms. C. D. Bullock, US Army Engineer Waterways Experiment Station

Investigation of Movement Algorithms in Army Models and Simulations
Major Michael E. Slavin, US Army Materiel Systems Analysis Activity

Wednesday, 0830-1000
Using a Time-Driven Model to Analyze the Aircraft Requirements for a Brigade Airdrop
LTC John A. Marin, Assistant Professor, US Army Department of Systems Engineering

Strategic Brigade Airdrop Force Mix Analysis
Maj Tom White, USAF, Air Mobility Command

Wednesday, 1330-1500
COMPOSITE GROUP III SESSION .... Bell Hall, Marshall Auditorium

Wednesday, 1515 - 1645
Airfield Capability Modeling
Capt Kim Schubert, HQ AMCSAF (XPY)

Airlift System Sensitivity to Perturbed Time-Phased Force Deployment Data
Capt Glenn Rousseau, Air Mobility Command Studies & Analysis Flight

Thursday, 0830-1000
Ground Vehicle Simulation: A Standard Model for the Three Modeling Environments
William Willoughby, PhD, US Army Engineer Waterways Experiment Station

A Tabu Search Based Heuristic for Site Selection Considering Ground Mobility
Mr. Jeff Williamson, Electronics Engineer, US Army Engineer Waterways Experiment Station

IPB Process Value-Added via Computer-Aided Procedures: Emerging Results
Mr. Niki C. Deliman, PhD, US Army Engineer Waterways Experiment Station

Thursday, 1330-1500
CONUS Redistribution Modeling
Capt Jean Steppe, HQ AMCSAF (XPY)

Mobilization Capabilities Evaluation Model (MOBCEM)
Ms. Julianne Allison, Operations Research Analyst, US Army Concepts Analysis Agency

WG 8 — MOBILITY — Abstracts

Tuesday, 1030-1200
Airlift Sealift Cycle Analysis Model

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Material flow into any theater of operation is dependent on both airlift and sealift operations. Integration of these modes of operation is critical to US Transportation Command (USTRANSCOM) and is currently being analyzed with large-scale simulation models. A new approach has been taken to aggregate these simulation model outputs (via regression analysis) and to build simple flow model representations of these complex systems. A family of spreadsheet-based models is being developed to represent complex airlift and sealift flow giving senior decision-makers the ability to rapidly perform "what-if" assessments at "near" real-time. An interactive airlift/sealift model will be presented showing the affects of various trade-offs.

Strategic Sealift Analysis System

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The Military Sealift Command, a component of the United States Transportation Command, is responsible for the sealift of military cargo during a crisis. Conceptual plans for these complex moves, called deliberate plans, are continually being prepared. A computer-based scheduling system, the Strategic Sealift Analysis System (SEASTRAT), has been developed to assist in the production of these plans. The ship scheduling portion of this system, the Scheduling Algorithm for Improving Lift (SAIL), combines linear optimization and heuristic methods to determine ship routes and cargo loading which honor a variety of complex operational constraints. The prototype system was developed in 1986 and the operational model came into operation in 1992, although not all components of SEASTRAT have been developed. Current plans call for SAIL to migrate into USTRANSCOM's Joint Flow and Analysis System for Transportation (JFAST) and for the SEASTRAT at MSC to be terminated. This paper provides a general description of SEASTRAT with emphasis on SAIL and discusses issues related to its planned migration to JFAST.

Optimization of the Air Mobility System

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As an alternative or adjunct to detailed simulations, linear programming (LP) can be used to resolve many of the questions raised concerning the air mobility system. The Air Force Studies & Analyses Agency and the Naval Postgraduate School's Operations Research Department have teamed up to develop a time-phased LP (THRUPUT) for use in analyzing force structure issues (e.g., fleet mix decisions and aircraft tradeoff analyses) such as the recent C-17/NDAA decision, as well as the impact on the mobility system of constraints on infrastructure (e.g., unavailability of bases or routes).

This effort pushed the LP tractibility envelope for commercial software. Formulations with 3 million nonzero coefficients were generated and transported over the Internet for analysis by a variety of LP experts. Inputs from these individuals led to selection of appropriate algorithmic options and significant problem reductions. By applying a combination of algebraic manipulation and insight into the mobility system, a large number of variables and constraints were either merged or eliminated altogether. These model reductions came not at the expense of solution resolution, but instead had the effect of more tightly defining the decision space. Currently, THRUPUT computes optimal time-phased cargo and passenger flows for hundreds of units over hundreds of routes, using a diverse fleet mix, in under three hours on a IBM RS6000 Model 590.

Tuesday, 1530-1700
Analysis of the Impact of Terrain Resolution on Modeling and Simulation Outcomes

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A high level of terrain correlation is required for simulations participating in a Distributed Interactive Simulation (DIS) environment to achieve consistent outcomes among the simulations, convey realism and impart credibility to the results. With respect to virtual simulations, each computer image generator (CIG) is constrained by the computational power available to depict images. Constructive models typically use raster format for elevations and features; although, models in the Janus lineage are using polygons to represent features. Line-of-sight (LOS) calculations are demanding consumers of processing capabilities in constructive simulations. As terrain resolution increases, LOS calculations, generally, increase as well. With these varying terrain representations and hardware restrictions, the question remains regarding the level of terrain resolution required for agreement in a DIS environment between live and the M&S domain. From an interoperability viewpoint each participant must

"see" and "interact" within the same terrain environment to ensure a "level playing field".

If technology and cost were not limiting factors, one might say that ground truth is the requirement for M&S. However, resources are indeed limited; consequently, prior to answering the terrain data resolution and correlation issues, the impacts, constraints, trade-offs, and associated costs of using varying terrain resolution in simulations, stand-alone and the DIS environment, must be thoroughly examined and analyzed. This paper discusses a quantitative and qualitative analysis of existing information relating to the impact of terrain resolution on M&S outcomes with respect to line-of-sight, battle outcomes processing and preprocessing time.

Investigation of Movement Algorithms in Army Models and Simulations

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This study was conducted to provide the Army community with an in-depth investigation of algorithms used to depict battlefield movement in selected models and simulations (M&S). Battlefield movement, as defined in the Army Modeling and Simulation Master Plan, includes platform/people performance, mobility, countermobility, suppression (effects on movement), formations, and dispersion. The report provides documentation of these movement algorithms to assist the standards Category - MOVE panel in their efforts to standardize movement algorithms.

Nine models were selected for inclusion in the study: CASTFOREM, JANUS, ModSAF, BBS, Groundwars, VIC, EADSIM, CCTT and CBS. These were considered to be a representative sample of Army models and simulations which covered the three M&S Domains (TEMO, ACR, and RDA) as well as viral and constructive M&S.

The study addresses, for each model, the algorithms pertaining to each of the categories of battlefield movement (performance, mobility/countermobility, suppression, formations, and dispersion). The analyses focus on: where algorithms exist in the models to depict each category; if so, an explanation of how the algorithms represent the physical aspects of the category; and the level of fidelity of these algorithms. Where appropriate, comments received from users of the models were listed at the end of each models' analysis. An overall summary of the results of the status of each of these battlefield movement categories is also presented.

The results demonstrate several interesting points. First, algorithms vary greatly between models, although there are some similarities among models with comparable levels of resolution. Second, watercraft are not represented in any of the selected models. Finally, the study did not address the data from which the algorithms derive their results. Therefore, although a model may contain a valid algorithm to depict a certain aspect of battlefield movement, the data may be flawed and consequently the end result is unreliable.

As a result of this study, several recommendations were made for the modeling and simulation community's consideration.

Wednesday, 0830-1000

Using a Time-Driven Model to Analyze the Aircraft Requirements for a Brigade Airdrop

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The requirement for future Strategic Mobility Systems is to ensure that combatant commanders are supplied with an effective fighting force in a timely and efficient manner. One aspect of the Strategic Mobility System is early entry, and one aspect of early entry is the brigade airdrop. The purpose of this research is to design a model that predicts the number of aircraft (C-5s and C-17s) needed to transport a brigade in a timely and efficient manner. In order to model the aircraft requirements, a PC software package called PowerSim was employed. PowerSim differs from traditional simulation packages in that PowerSim creates a time-driven model rather than the usual event-driven model. Breaking-down the brigade airdrop into four phases (Home station, Onloading, Stage Base, and Target), the PowerSim model uses applicable probabilities and stochastic routines to predict the number of aircraft that advance to a given phase, advance to maintenance, or leave the system. Results and sensitivity analysis are also provided.

Strategic Bridage Airdrop Force Mix Analysis

Craig M. Northrup, Colonel, USAF, Thomas P. White, Major, Alan Whisman, GS-13
Chief, Command Analysis, Directorate of Plans, Air Mobility Command Studies and Analysis Flight
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This paper describes the use of simulation in concert with a meta-model to improve understanding of the strategic brigade airdrop (SBA) mission, enabling decision makers to size and structure the future strategic airlift fleet to support this joint military requirement. The simultaneous reduction of our military presence overseas and our total military force heightens emphasis on rapid mobility. The strategic brigade airdrop is an essential part of our force projection strategy, particularly key to forced entry. This mission involves airdropping personnel and equipment to capture and hold a target airfield, then airlanding the completing and sustaining forces. It may be used to establish an air head or to capture and hold a key strategic or tactical target.

Simulation is used to predict performance of alternative mixes of strategic airlift aircraft tasked with an SBA. Key SBA activities are modeled in the context of existing airlift infrastructure, revealing limiting factors in the system. Alternatives for the decision logic governing the allocation and sequencing of aircraft in the simulation are explored to find the most effective concept of operations. Finally, resulting aircraft

performance data is extrapolated within a meta-model to predict performance for a wide variety of contingencies. The resulting interactive decision support system enables decision makers to explore a variety of cases, gauging the key sensitivities and narrowing the focus for further analysis. Results from this analysis were briefed to the C-17 Defense Acquisition Board (Nov 95) and had a direct bearing on the decision to acquire 120 C-17s.

Wednesday, 1330-1500
COMPOSITE GROUP III SESSION
Bell Hall, Marshall Auditorium

Wednesday, 1515 - 1645
Airfield Capability Modeling

Capt Kim Schubert, Mr. Alan Whisman,
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An important component of air mobility throughput analysis concerns quantifying airfield capacity. The Base Resources and Capabilities Estimator (BRACE) is a modeling tool developed by AMC Studies and Analysis Flight to improve understanding of airfield throughput capacity. BRACE is a discrete-event simulation, taking a scheduled flow of aircraft arriving at an airfield and simulating aircraft movements through the various ground activities lending to a departure. By varying aircraft types, payload profiles, and duration of ground activities, we gain insight into the resources required to sustain a level of throughput and how this equates to the airfield's "working MOG." MOG is an aggregate measure of resource support primarily based on expert opinion, not on quantitative analysis. This insight into "working MOG" is important for making decisions regarding infrastructure, aircraft, and aircrews. In this presentation, we will describe airfield modeling in more detail, present a SLAM simulation model developed for stochastic airfield capability modeling, and illustrate operational results of the model.

Airlift System Sensitivity to Perturbed Time-Phased Force Deployment Data

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This research perturbed the airlift requirements outlined in time-phased force deployment data (TPFDD) and evaluated the effects of those perturbations on airlift system performance. Specifically, four characteristics for two TPFDD files were perturbed and then fed into the Airlift Flow Module (AFM) simulation. Small, constrained perturbations were made to the specified locations, the time line, the amounts of cargo and passengers, and the proportion of outsize and oversize cargo categories. The effects these perturbations had on AFM output were interpreted using factor analysis. Factor analysis reduced the dimensionality of the large output data sets and was the principal means of quantifying sensitivity. The computed factor scores, when plotted against one another, provided sensitivity plots, graphically depicting the sensitivity of the airlift performance response to the perturbations. Counter to recent airlift analysis discussions which promote completely unconstrained random TPFDD generation, this research indicated that small, constrained variations could cause potentially significant and unpredictable changes in airlift performance. Of potential interest to the simulation community, another by-product of this research was the potential to use factor analysis as a verification and validation tool for large, complex simulation models.

Thursday, 0830-1000
Ground Vehicle Simulation: A Standard Model for the Three Modeling Environments

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Futuristic, highly agile, and lightweight vehicles with new power-trains (e.g., electric drive, modular unit, robotics) and improved suspensions (e.g., active damping, hydropneumatic) will require more responsive algorithms to accurately predict vehicle mobility. Prototyping in a virtual environment would permit evaluating design changes to concept vehicles without expending tax-payer's dollars on building prototype vehicles. The inclusion of a standards-based, high-fidelity ground vehicle simulation module will greatly increase the accuracy of vehicle prototyping. Moreover, the same module could be implemented into training simulators to insure realistic representation of vehicle mobility on ground vehicle training. Non-standard representation lead to inconsistent results, especially across Distributed Interactive Simulations (DIS).

The objective of this research thrust is to develop a high fidelity ground vehicle mobility module (GVSM) for inclusion in the Comprehensive Army Mobility Model-Developmental and other models in the live, virtual, and constructive modeling environments. The GVSM will permit the accurate and realistic representation of vehicle trafficability and dynamics over hard and soft soils, crossing wet (fording/swimming) and dry gaps, human factor effects on vehicle performance (i.e. dust, rutting, etc.).

A Tabu Search Based Heuristic for Site Selection Considering Ground Mobility

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Support elements on the battlefield must be able to respond quickly and effectively to the demands of other elements on the battlefield. The sites on which these support elements are stationed must be strategically selected to allow support elements, such as supply elements, to reach the demand points within a

specified time frame. The time required to provide this support is crucial and must be minimized.

Military vehicles move on-road and off-road in sometimes challenging conditions. With the introduction of off-road travel, the military site selection problem becomes far more complex than similar civilian site selection problems, such as locating emergency medical services and commercial distribution centers.

The major effort of this research was devoted to developing a methodology that would maximize coverage within an area of operations and minimize the number of facilities needed to provide the coverage within a specified time frame.

The methodology developed incorporates a modification of the tabu search procedures and utilizes the time contour analysis algorithms developed by the Waterways Experiment Station. A computer based tactical decision aid incorporating this methodology was developed within the Comprehensive Army Mobility Model System - Developmental (CAMMS-D) which meets the geographic information system (GIS), user interface, and graphics requirements for demonstration.

The purpose of this presentation is to describe the problem formulation and solution methodology.

IPB Process Value-Added via Computer-Aided Procedures: Emerging Results

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Intelligence Preparation of the Battlefield (IPB) functions related to mobility at brigade-level are typically time sensitive, time consuming procedures performed manually. The S-2 largely depends on materials at hand to support the commander. The interpretation of available materials, including maps, per se is subjective and does not incorporate many factors affecting ground mobility. Computerized procedures that incorporate multiple factors in evaluating ground vehicle mobility exist but are not readily available at echelons brigade and below. These methodologies potentially offer increased quality, consistency, objectivity, and completeness in products and analyses as well as time savings for the analyst.

It is important to evaluate the value added by incorporating such automated procedures into interactive, geo-referenced systems that can be utilized in the IPB process at echelons brigade and below. In support of this objective, a study is being conducted to identify mobility-related IPB functions that can be automated to improve the IPB process. This study involves comparing manual and computer-aided IPB procedures using designed experiments to measure value added. Surveys are being used to elicit information concerning perceived benefits derived from the computer-aided approach. The purpose of this paper is to present emerging results gathered from experiments conducted with the Military Intelligence Officer Advanced Course in Fort Huachuca, Arizona.

Thursday, 1330-1500
CONUS Redistribution Modeling

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Under the sponsorship of the Global Patient Movement Requirements Center of the United States Transportation Command and United States Atlantic Command, HQAMC/XPY is developing a decision support tool to explore the impact of policy decisions concerning bed activation and CONUS redistribution. The prototype decision support tool has been designed with an interactive front end and an interactive back end for exploring various casualty reception and casualty redistribution CONOPs. The tool presents results from a simulation of the time-phased casualty reception requirement which implements "user-defined" bed activation and bed assignment decision rules. Two outputs of prime interest to the customers are the identification of a bed shortfall and the generation of a time-phased CONUS redistribution lift requirement.

Mobilization Capabilities Evaluation Model (MOBCEM)

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MOBCEM will be a critical tool for providing CAA and the Army with the ability to evaluate and improve mobilization capability. The model will provide the capability to simulate mobilization operations and analyze theater capabilities and shortfalls in connection with major force structuring studies. It will also allow for mobilization analysis of capabilities and issues independent of the theater combat models. MOBCEM will model the mobilization system from Home Station to Port of Embarkation and will include the modeling of Active Component and Reserve Component units, individual personnel, and materiel at all levels of mobilization through full mobilization. When completed, this tool will allow CAA, the ARSTAF/MACOMs, and OSD to respond to requests for studies and analyses of various aspects of the mobilization process.

Over the past year, a MOBCEM prototype was developed. The prototype's focus is on the Mobilization Station (MS). All services, e.g., billeting, medical processing, validation, etc., are represented at the MS. The other major nodes (Home Station, CONUS Replacement Center, National Training Center, and Port of Embarkation) are represented but consist of queues only (no services have been implemented). Upon satisfactory completion of testing and subsequent revisions, the prototype will be used as the basis for the full-scale system. Full-scale model development started in September 1995. Phases I and II will constitute the Army version of MOBCEM and are expected to be completed by the spring of 1997. The mobilization processes of the other services will be added in Phase III. MOBCEM will be a component of the Joint Warfighting System (JWARS). This presentation will cover the features, capabilities, status, and potential applications of MOBCEM.

WG 9 — AIR WARFARE — Agenda

Chair: Thomas M. Lillis, McDonnell Douglas Aerospace
Cochairs: Maj Ray Hill, AFSAA/SAG
Capt Donald A. Parish, NAIC/TAAE
Advisor: David E. Spencer, FS, RAND
Room: GIF, 353-C

Tuesday, 1030 - 1200
QUICK STRIKE - Combat Forces Assessment Model Development And Capabilities
Capt Paul W. Campbell, AFMC OAS/DRC & Dennis Coulter, ASI Systems International

Tuesday, 1530 - 1700
Impact of Off-board Assets on Strike Aircraft Air-to-Surface Effectiveness
Leonard Gorospe, Northrop Grumman Corporation

Standoff versus Direct Attack: Issues and Analysis for Ground Attack in the Future
Kenneth V. Saunders, RAND

Effects of Kill Removal Techniques on F-15 Open-Air Flight-Test Measures of Effectiveness
James G. Terry, SAIC

Wednesday, 0830 - 1000
Missile Comparison Range Charts
Capt Donald A. Parish, NAIC/TAAE

Short Range Missile Engagement Reconstruction
1Lt Joseph L. Mason, NAIC/TAAE

Threat Tactical Employment Simulation: An Engagement Analysis
Captain Dwight D. Fullingim II, NAIC/TAAE

Wednesday, 1330 - 1500
COMPOSITE GROUP III SESSION .... **Bell Hall, Marshall Auditorium**

Wednesday, 1515 - 1645
Weapons Effectiveness Study
Major Kenric Smith, AFSAA/SAGW

Overview of Methodology Used to Conduct the Deep Attack Weapons Mix Study
James N. Bexfield, IDA

Thursday, 0830 - 1000
Attack Helicopter Effectiveness in the Korean Peninsula
Wyoming B. Paris Jr., AMSAA

Integration of U-2 Capabilities into AFSOC Requirements
Paul G. Roberts & Thomas H. Plank, Sverdrup Technology, Inc

Thursday, 1330 - 1500
Use of Genetic Algorithm in Theater Warfare Analysis
Bruce A. Dike, McDonnell Douglas Aerospace

Tuesday, 1030 - 1200

QUICK STRIKE - Combat Forces Assessment Model Development And Capabilities

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The Air Force has historically maintained four different munitions allocation models to support POM estimates, operations planning, and requirements studies for weapons. The use of different models often led to inconsistent results, creating confusion in the munitions community and Air Force. In addition, each model required data in its own unique format, forcing each using organization to create largely duplicate databases. In January 1995, the Air Force formed the Munitions Model Working Group to consolidate three of the existing munitions models (TAM, HEAVY ATTACK, and MIXMASTER) into a single model now known as QUICK STRIKE. This consolidation has allowed the best aspects of the original models to be combined with many new ideas for this class of campaign analysis tools. This presentation will address the development of the QUICK STRIKE model and provide an overview of QUICK Strike's capabilities. QUICK STRIKE is an optimization, but models stochastic factors such as target regeneration, weather, and battle damage assessment. A few of the key capabilities include the ability to model simultaneous major regional conflicts, the ability to control CONOPs in the model, and a goal-oriented approach to optimizing the allocation. We will discuss our current experience with QUICK STRIKE and its use in determining Air Force FYDP munitions requirements.

Tuesday, 1530 - 1700

Impact of Off-board Assets on Strike Aircraft Air-to-Surface Effectiveness

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A vast array of offboard assets will exist in the 21st century, including such assets as JSTARS, AWACS, Rivet Joint, and unmanned aerial vehicles. Utilization of these assets by future strike aircraft may provide an increase in strike mission effectiveness, a reduction in strike mission costs, and/or a relief in onboard avionics requirements. Design of affordable strike aircraft requires an understanding of the benefits and limitations of cooperative operations over strictly autonomous. In this paper, mission decomposition is used to identify critical mission phases, tasks, and information requirements. The information requirements are examined through sensitivities and trades on onboard capability and available offboard information sources and content. Mission effectiveness and cost drivers are assessed and identified through the use of parametric, probabilistic, mission level, and engagement level analysis. Preliminary results reveal the importance of timely, accurate data from offboard sources for the attack of mobile and relocatable targets. Evaluations of future offboard architectures and their impact on mission effectiveness, mission costs, and onboard sensor requirements are continuing.

Standoff versus Direct Attack: Issues and Analysis for Ground Attack in the Future

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This paper focuses on the trucking or busing issue in the direct-attack (DA) versus stand-off (SO) debate. The issue is driven by the relatively high and growing unit cost of DA aircraft, per weapon carried, and the relatively high unit cost of SO weapons. The paper argues that to make level-playing-field comparisons between these two kinds of forces, costs of aircraft and weapons should be combined for each. It then compares the force costs -- in this sense-- of hypothetical future DA and SO forces that would do the same job. The job is to inflict the same damage on a target set in the same time, e.g., a phase of a campaign. If future individual DA and SO weapons were equally

effective, the common job might be to deliver on the target set 50K weapons in 30 days. One of the results is the following simple rule-of-thumb requirement: To make a DA force cost-competitive, the number of weapons each DA aircraft needs to deliver in doing the job must equal or exceed the ratio: unit cost of a DA aircraft ~~per weapon carried on a sortie~~ to the unit cost of an equally effective SO weapon. When the effects of attrition of DA aircraft are included things are complicated enough that a graphic is needed. The paper also shows the effects on the rule of the unit costs of DA weapons and SO aircraft, the latter's usage, and several other parameters.

Effects of Kill Removal Techniques on F-15 Open-Air Flight-Test Measures of Effectiveness

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At the turn of the century, the F-22 Test Team, Headquarters, Air Force Operational test and Evaluation Center (AFOTEC/TFF), Kirtland AFB NM, will conduct F-15 flight tests to be flown as part of the OSD-mandated F-22/F-15 Comparison Test (CT), and adjunct to F-22 Initial Operational Test and Evaluation (IOT&E). To support the planning for these flight tests, AFOTEC/TFF is sponsoring, under contract with SAIC, analyses using BRAWLER, an m-v-n air-to-air engagement simulation, to investigate open-air flight-test issues. Among the issues being investigated: What are the effects of different levels of flight-test kill removal upon flight test measures of effectiveness (MOEs)?

This presentation describes the modifications made to BRAWLER to model open-air flight testing, and it then describes the analyses of classified F-15 and unclassified generic fighter flight-test scenarios. Actual-combat MOEs, as modeled by BRAWLER, were used as baseline measures. Different levels of flight-test kill removal were simulated by selecting various kill-removal system reaction times, then directing declared-dead flight-test aircraft to depart the engagement with a standard "I am dead" maneuver after those reaction times expire. A "zero-kill" case in which no kill removal is used was also simulated.

Statistically-significant differences were observed between the MOEs of some actual-combat scenario. In those cases the use of "near real-time kill-removal resulted in MOEs which did not display statistically-significant differences. These observations will play a significant role as AFOTEC/TFF plans test-range configurations for CT and IOT&E flight testing.

<u>*Wednesday, 0830 - 1000*</u>
Missile Comparison Range Charts
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Simulation of fighter aircraft engagements revealed differences in effectiveness for various beyond-visual-range air-to-air missiles. The Brawler simulation was used to test the effectiveness of different missiles in a simulated one versus one engagement. The allowed missile launch range was varied from minimum to maximum effective ranges for each set of initial conditions. In each case, both aircraft fired one missile at a set range and disengaged after their missile actively tracked the target. The results of the engagements were plotted on a launch range grid which revealed regions where each side may have an advantage or disadvantage for different launch distances.

Short Range Missile Engagement Reconstruction

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Trajectory data for a short-range infra-red missile with high off-boresight capability was used to reconstruct several live-fire engagements. The live fire trajectory data was reconstructed using NAIC's advanced missile flyout models. A video tape of the reconstructed engagements was created. The analysis shows the missile's high crossing rate, high off-boresight, minimum range, and no escape range capabilities.

Threat Tactical Employment Simulation: An Engagement Analysis

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This study was conducted to assess the combat effectiveness impact of threat tactics against the F-15C with AIM-120, AIM-9, and AIM-7 weapons loadouts. Threat weapon systems included the Fulcrum, Flanker, Flogger, and upgraded Fishbed with various combinations of AA-7, AA-10, AA-11, and AA-x-12 air-o-air missiles. The BRAWLER air-to-air engagement model was used to perform the simulation. The tactics were produced using the BRAWLER production rules capability. The F-15C flew Beyond-Visual-Range (BVR) offensive counter air (OCA) tactics based on RULES provided by Air Force Studies and Analysis Agency. The threat aircraft flew BVR defensive counterair air (DCA) tactics based on National Air Intelligence Center threat tactical RULES. Effects of commit ranges, weapons employment ranges and weapon types were examined.

<u>*Wednesday, 1330 - 1500*</u>
COMPOSITE GROUP III SESSION
Bell Hall, Marshall Auditorium

<u>*Wednesday, 1515 - 1645*</u>
Weapons Effectiveness Study

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The Weapons Effectiveness study was conducted to update the 1990 Air Force Conventional Weapons Program Assessment. Specifically, the Weapons and Tactics Branch of Air Force Studies and Analyses Agency, along with ASI-System International, examined and evaluated the relative military value of all current and planned Air Force conventional weapons, budget and unit cost changes, and the effect of force structure and attrition changes on the weapons program. The results of the study provided senior decision makers with analysis that can be used to make munitions and force structure decisions in a declining budget environment.

Overview of Methodology Used to Conduct the Deep Attack Weapons Mix Study

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Approved abstract not available at printing.

Thursday, 0830 - 1000
Attack Helicopter Effectiveness in the Korean Peninsula

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This analysis evaluates the effectiveness of attack helicopter antiarmor operations in the Korean Peninsula. It was a joint Republic of Korea Army (ROKA) Army, Army Material Systems Analysis Activity (AMSAA) project.

With the assistance of the TRAC Leavenworth World Class Opposing Force (WCOPFOR) Group and the AMSAA Foreign Intelligence Office (FIO), we have developed a realistic, detailed, unclassified Korean Peninsula scenario depicting a North Korean Peoples Army (NKPA) tank attack across the Western end of the Demilitarized Zone (DMZ) toward Seoul. Four NKPA Infantry Divisions in the attack face for ROKA Infantry Divisions in the defense. Each ROKA division is supported by a Attack Helicopter Battalion containing twenty-four attack helicopters armed with antitank guided missiles (ATGM's) and 20mm secondary armament. Both the attack helicopters and their ATGM's are "generic" in nature, having been derived by averaging the unclassified characteristics of several of the more interesting systems on the international scene.

The objective of this analysis is to investigate the potential effectiveness of the attack helicopter in attriting an armor thrust in the particular Korean Peninsula terrain of interest. Specifically:

- Conduct a sensitivity on cross-FLOT depth of attack (deep against armor assembly and staging areas, medium deep against armor convoys in the road march, and immediately across the FLOT against armor deployed in the attack formation actively engaging in the assault),
- Compare AH effectiveness in single target "strikes" versus multiple target "raids", through lightly defended and heavily defended areas,
- Investigate sensitivity to some of the major aircraft and missile effectiveness parameters (aircraft) ordinance load, sensor range, missile range, etc.),
- Assess day versus night missions benefits and countermeasures potentials.

In addition to providing an effective tool to implement the exchange of military operations research and model methodology, this study, using the AMSAA Evaluation of Air Defense Effectiveness (EVADE) model, its digitized terrain preprocessor (MASKPAS), and its dynamic graphics postprocessor (IVIEW) has employed the new Defense Mapping Agency CD ROM worldwide database (for the Korean Peninsula), and utilized networked Silicon Graphics computers for program development and analysis.

This study is completed and has been briefed: to the Deputy Under Secretary of he Army for Operations Research (UDSA-OR), to MG Kong Ok Park at the S. Korean Embassy, at the Joint s. Korean/US Army Aviation Seminar at Taejon, Korea in June 95, and at Defense Analysis Seminar (DAS) VIII at Seoul, S. Korea in Oct. 95.

Integration of U-2 Capabilities into AFSOC Requirements

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There is an urgent and growing need to leverage technologies and capabilities in revolutionary ways to provide in-time intelligence support at all levels, including the individual warfighter. The paper explores feasible options for exploiting U-2 Reconnaissance System capabilities, beyond their traditional role, to provide solutions to Air Force Special Operations Command (AFSOC) operational intelligence deficiencies identified in formal requirements documents. The paper discusses how the combined elements of aircraft performance characteristics, sensor capabilities, data links, and ground processing stations make the U-2 a unique system to support the critical needs of special operation forces (SOF) for near-real-time intelligence.

A representative scenario is included that illustrates specific examples where U-2 capabilities could provide in-time intelligence during the mission planning, rehearsal, and execution timelines. With the U-2 likely to already be operating where SOF are employed and the connectivity between the U-2 CARS ground station and AFSOC intelligence support systems already existing within the current C4I architecture, the paper concludes that U-2 capabilities can be effectively integrated in support AFSOC requirements. However, an increased understanding of each other's capabilities and mission requirements within the U-2 and SOF communities is needed to realize the full potential of integration.

Thursday, 1330 - 1500

Use of Genetic Algorithm in Theater Warfare Analysis

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Approved abstract not available at printing.

WG 10 — LAND WARFARE — Agenda
Chair: Larry Cantwell, TRADOC Analysis Center
Cochair: Thomas Iten, Electrospace Systems, Inc.
Advisor: Phillip Kubler, TRADOC Analysis Center
Room: Bell Hall, CR-6

Tuesday, 1030 - 1200
Antiarmor Requirements and Resource Analysis (A2R2)
Stanley Gray and Richard Laferriere, TRADOC Analysis Center - White Sands Missile Range

Analytical Modeling's Links to the Force XXI Command Post
CPT(P) Gregory A. Palka, TRADOC Analysis Center

Meeting Requirements of the Twenty-first Century Soldier: Simulation of Emerging Countermine Technologies in Expand the Lodgment and Operations Other Than War
Jeffery R. Kramer and CPT Mark A. Moulton, TRADOC Analysis Center - White Sands Missile Range

Tuesday, 1530 - 1700
Estimating Simulation Error With Resampling
Fred Ahrens, Hughes Missile Systems Company

Obstacle Planner Software
Phillip L. Doiron and Cary D. Butler, U.S. Army Engineer Waterways Experiment Station

Making the Soldier More Lethal, The Objective individual Combat Weapon
MAJ Rocky Gay, United States Military Academy

Wednesday, 0830 - 1000
Verification, Validation, and Accreditation (VV&A) of Distributed Interactive Simulations
Pamela Blechinger, TRADOC Analysis Center and Simone Youngblood, Illgen Technologies

Verification, Validation, and Accreditation of the Close Combat Tactical Trainer: A Practical Application of the VV&A Process
Dr. Robert Wright, Resource Consultants, Inc. and MAJ Jeff Browning, PM CATT

SAF Combat Instruction Sets; Key to Doctrine Based Software Development
Brian R. McEnany, Edward Chandler, Irvin Jacobs and Garrett Fonda, SAIC

Wednesday, 1330 - 1500
Special Operations Simulations in Janus
CPT Jim Griffen and CPT Mark Blackburn, TRADOC Analysis Center

Data Standards and Leveraging Technology for Organizing the Data; a U.S. Army M&S Overview
Howard Haeker, TRADOC Analysis Center

82nd Airborne Division OPLAN Analysis - Planned Invasion of Haiti 1994
LTC John R. Ferguson, TRADOC Analysis Center - White Sands Missile Range

Wednesday, 1515 - 1645
Hazard From Industrial Chemicals
Charles R. Crawford, U.S. Army Edgewood RD&E Center

Hierarchically Echeloned Laydown Planner with Equipment and Renderings (HELPER)
Cyrus E. Holliday, ASI - Systems International

Innovations in Field Artillery Force Structure
Patrick G. Smock and CPT Kenneth M. Higginbotham, TRADOC Analysis Center

Thursday, 0830 -1000
Real Time Battlefield Analysis (RTBA)
Eduardo B. Garcia, USASSDC

Conducting Warfighting Experiments at the National Training Center
Dr. Jon Grossman, RAND

DIS User Requirements for Advanced Concepts and Requirements (ACR) Analysis
Diane Schuetze, LTC Mike Kallman, and MAJ Jerry Bradshaw, HQ TRADOC

Thursday, 1330 -1500
Leveraging Hierarchical Scenarios for Analysis
William J. Krondak, TRADOC Analysis Center

Longbow Countermeasures Assessment
Luis Dominguez, Ben Morgan, David Hastings, and Doug Mackey, TRADOC Analysis Center - White Sands Missile Range

Polling vs. Event-driven Computer Generated Forces (CGF) Architectures
Michael K. Adkins, TRADOC Analysis Center

Acoustics in Computer Generated Forces
Robert L. Albright, TRADOC Analysis Center

WG 10 — LAND WARFARE — ABSTRACTS

Tuesday, 1030 - 1200
Antiarmor Requirements and Resource Analysis (A2R2)

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The Antiarmor Requirements and Resource Analysis (A2R2) was commissioned by the Deputy Chief of Staff for Operations (DCSOPS), Force Development Office. The TRADOC Analysis Center was designated as the study agency. The purpose of this analysis was to provide an updated assessment of antiarmor munitions and systems requirements to support the building of the Army's 98-03 program objective memorandum (POM). The base case includes existing systems in the force as well as systems that were predetermined to be in the 98-03 POM. The study is divided into two phases to consider, the near term (year 2005) and the far term (year 2015). The analysis will cover both the close and deep battle problems and, where possible, consider implications of TF XXI concepts. Simulation results will be supplied to the U.S. Army Concepts Agency (CAA) for performance of the resource analysis. The U.S. Army Materiel Systems Analysis Agency (AMSAA) was also tasked to perform a performance and sustainability analysis on all systems considered in the requirements analysis. The results from the model runs were input to the TRAC mix model to establish; 1) the optimum family of systems/munitions considering both lethality and survivability and, 2) a one-to-one list of systems/munitions considering both effectiveness and cost. This paper will present the highlights of this effort.

Analytical Modeling's Links to the Force XXI Command Post

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This paper will illustrate the need for the analytical modeling community to expand the interaction with the CINCs, subordinate commanders and staffs in analyzing the actual contingency and operations plans for the specific theater or operation. The first version of the Army Tactical Command and Control System (ATCCS) will be fielded in the next five years. These devices will be the primary tools the commander and staff will use in correlating, filtering, processing, extracting, and formatting information for the force.

The focus of this paper is the ATCCS, specifically the Maneuver Control Station's ability to automate the wargaming and course of action analysis process during the commander and staff's conduct of the Command Estimate Process and how this new *automated* wargaming relates to current Corps, Division and Brigade analytical modeling being conducted by Army modeling agencies. With the advent of automated wargaming (i.e. analytical modeling) in the future command post, one group of future military analysts is the young officers and non-commissioned officers serving in staff and command positions in brigade and higher command posts. These *future military analysts* have little knowledge and no training in the conduct of automated wargaming and the implications it has on the decision making process. The modeling community should begin now to inform, and instruct the future analysts and commanders on the use of automated wargaming results by modeling the current *real world* contingency and operations plans. The Army Modeling Community should greatly expand the analytical modeling work with the CINCs, and subordinate commanders and staffs to ensure we effectively train and grow the next generation of military

analysts and decision makers in the effective use of analytical modeling results. This exposure will have the following advantages. First, when the new wargaming technologies are fielded on the battlefield, leaders will be ready to exploit the capabilities effectively and recognize the weaknesses. Second, the modeling community and commanders will have a set of base scenarios to compare and contrast the results produced by the ATCCS systems. Finally, the Army can begin the examination and probable revision of the tactics, techniques and procedures commanders and staffs use to implement the Command Estimate Process and the possible results they will have on the outcome of battle.

Meeting Requirements of the Twenty-first Century Soldier: Simulation of Emerging Countermine Technologies in Expand the Lodgment and Operations Other Than War

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Recent conflicts across the globe have demonstrated an increased use of mines as an active ingredient of land warfare across the entire spectrum of war. In the low intensity conflict and during Operations Other than War (OOTW), mines will become the principal offensive and defensive weapons of the enemy. Mines will range from state-of-the-art conventional mines to simple, but effective, "home made" devices. Mine warfare is one of the principal weapons employed by threat forces to cause maximum casualties and disruption while minimizing the necessity for direct combat actions against our larger, more powerful forces. As such, mines will be used for all the above reasons plus the interdiction of lines of communications, harassment, and ambush roles. Additionally, latent, unrecovered mines and minefields can still paralyze civil and military forces long after the cessation of hostilities. The current multifaceted, unstable world may require U.S. Army operations ranging from combat missions in regional conflicts, to various OOTW missions such as peacekeeping, humanitarian assistance, and counter drug operations. As such, U.S. forces may face enemy operations ranging from isolated banditry through terrorism, insurgency, guerrilla warfare, and conventional combat operations. These enemy forces may be equipped with a variety of foreign and domestic mine systems spanning the full gamut of sophistication. What tools will future dismounted soldiers have to deal with this increasingly dangerous and menacing threat? What countermine technologies hold promise for continued development? This paper reports on simulations of potential countermine technologies in Expand the Lodgment and OOTW combat situations using the CASTFOREM model.

Tuesday, 1530 - 1700
Estimating Simulation Error With Resampling

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Analysts require adequate tools for gauging the amount of error in their simulation results. Measures of effectiveness from modern combat simulations can present special problems in error estimation. These problems include correlation between runs, unequal variances, non-normal distributions, and non-linear functions. Resampling is a powerful technique for analyzing data errors which do not satisfy the assumptions of classical statistics. This method is conceptually accessible to the analyst with nominal statistics training, and can be performed with ordinary spreadsheet software.

This paper will describe how resampling has become a leveraging technology for the analyst at Hughes. We will see problems from land warfare and air defense where the assumptions of classical statistics fall. The concept of resampling will be introduced and applied to these problems to provide meaningful estimates of simulation error. The discussion will also provide insight on methods in experiment and simulation design which help reduce simulation error.

Obstacle Planner Software

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The Obstacle Planner Software (OPS) is an ongoing research and development program within the Corps of Engineers focused on automating the combat engineer's role in the decision process. This includes providing decision support tools that directly support the engineers in mission analysis, course-of-action development, and course-of-action analysis. OPS builds on past and present research and development efforts in engineer mobility and countermobility. The typical results of this research are physics-based models that require very descriptive inputs and provide a level of detail necessary for engineers to plan and execute their missions. The synergism between existing artificial intelligence technologies and the physics-based engineering models supports the creation of decision algorithms that allow engineers to provide realistic assessments of engineer operations to the commander to meet the requirements of FORCE XXI.

Since the program started, OPS has continually increased its capabilities of automating the engineer's decision process. OPS recent participation in Prairie Warrior 95 (PW95) allowed the engineers, for the first time, to digitally plan and transmit engineer related information horizontally and vertically among the echelons. One contributing factor in the success of OPS during PW95 was its ability to manage tremendous quantities of Defense Mapping Agency feature data and use these data in performing detailed analysis for use by the decision makers. During FY95 the capabilities were expanded by the addition of a relational database (used in modeling the situational awareness) and a rule-based expert system (used to model human expertise or knowledge).

Making the Soldier More Lethal, The Objective Individual Combat Weapon

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The American fighting soldier must take advantage of new technology to increase its lethality on the battlefield. We have improved the combat effectiveness of many other battlefield operating systems; yet, the foot soldiers remains neglected. The U.S. Army Soldier System Command Center (Natick, MA) coupled with the Army Research Development Engineering Center (Picatinny Arsenal, NJ) want to increase the mobility, survivability, reliability and lethality of the most precious system on the battlefield, the infantry soldier. These organizations have developed the Objective Individual Combat Weapon (OICW) to enhance the lethality of the soldiers, as well as, the infantry squad. Can the infantry squad be a more lethal and valuable killing asset on the battlefield? How many OICWs are needed on the battlefield? What are the best type of missions to deploy OICWs in? In what type of terrain can the characteristics of the OICW be most effectively utilized to strengthen the "fightability" of the light infantry squad? Janus combat simulations will be used to evaluate these various organizational, mission and terrain alternatives and situations and determine their effectiveness on the battlefield.

Wednesday, 0830 - 1000
Verification, Validation, and Accreditation (VV&A) of Distributed Interactive Simulations

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The Department of Defense is moving to institutionalize the development and use of Distributed Interactive Simulations (DIS). Currently, procedures to verify, validate, and accredit models and systems joined in a distributed simulation environment have been developed in a consensus environment within the DIS Workshops. These procedures are described in a draft IEEE Recommended Practices document and are discussed in this presentation.

The belief that models and simulations (M&S) that have undergone individual V&V processes will produce credible results when linked in a DIS exercise is a common misconception. Interactive M&S may produce unexpected effects leading to unpredictable results. Non-homogeneity among the M&S can create conditions favoring one over another, either randomly or on a continuous basis. Network latency can cause the same effect. The procedures outlined in this presentation were designed to lessen the potential impact of these types of effects.

This presentation will outline the technical aspects of each step and show the audience a methodology for developing a cost-effective VV&A plan for distributed simulation applications. Included will be a discussion concerning VV&A tailoring for different development paradigms and a process for determining the cost of each V&V program as a percentage of program development costs.

Verification, Validation and Accreditation of the Close Combat Tactical Trainer: A Practical Application of the VV&A Process

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The requirements for Army model and simulation program verification, validation and accreditation (VV&A) are outlined in Ar 5-11 and DA Pam 5-11. The Close Combat Tactical Trainer (CCTT) is the first major Army Training model and simulation program to undergo the rigors of these regulations. This paper reports on the procedures used to develop the CCTT VV&A program. The paper discusses the various agencies involved, the tests to be conducted, the tools to be used in the VV&A process and the importance of traceability. The paper also compares the VV&A process developed for CCTT to the Distributed Interactive Simulation (DIS) 9-step VV&A process.

SAF Combat Instruction Sets Key to Doctrine Based Software Development

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One of the most difficult efforts in any Computer Generated Forces simulation effort is to provide a robust process for the capture and validation of tactical behaviors. The Close Combat Tactical Trainer (CCTT) Semi-Automated Forces (SAF) is the largest behavioral simulation effort ever under taken by the U.S. Army. The Integrated Development Team (IDT), working closely with STRICOM, developed an approach that traces validated combat behaviors from their approved sources in Army (BLUFOR) and opposing forces (OPFOR) tactics and doctrine to computer representations in CGFs. To address this difficult requirement, the IDT created a process to ensure that traceability into the software code representing them existed.

This paper is an extension of one presented at the 4th Computer Generated Forces Conference in 1994 by Brian McEnany and Henry Marshall. The original paper explained the process for accurately capturing and recording the tactical behavior extracted from documents and turning it into a structured, usable format for use by software engineers. The format, an English language combat instruction set (CIS) or natural language description of specific unit collective tasks, was jointly developed between the IDT, TSM-CATT and STRICOM. The final CIS structure has been upgraded several times and over 700 have been produced under the CCTT program. They are currently being used

by the Army in several CGF projects, such as the A2ATD program where MODSAF behaviors are compared to validated CIS descriptions during validation.

All CISs were validated through appropriate TRADOC schools and the Threat Support Division at Fort Leavenworth. No formal combat behavior code, based on these CISs, was entered into the CCTT baseline until approval of the CIS was received. All validated CCTT CISs are currently available on-line through STRICOM's CATTASK database.

This paper provides a short review of the necessity for standardizing the manner in which CISs are created, the types of information required to support collective task training simulations, and describes, in more detail, the internal validation of CISs as they are implemented in code. A new term "visual validation" has been used to focus attention upon the ultimate use of SAF tactical behaviors in a training simulation. This term will be described in relation to existing V&V definitions and examples of the conduct of visual validation as part of ongoing program development will be explained.

CCTT SAF CIS development and analysis has led to behavior code closely tracking tactical behaviors. It has facilitated knowledge transfer from subject matter experts to software developers. It is allowing identification of common task and results in a rigorous knowledge capture, transfer, and translation process for development of CGSs. The products (CISs) are now being used to evaluate other CGSs in the community. Extension of more rules in CGSs requires absolute control over the validation of the tactical behaviors that are represented. The process of extending such rules to other CGFs will continue to be extremely important and will play a critical role in the credibility of results over time.

Wednesday, 1330 - 1500
Special Operations Simulations in Janus

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Requirement: With an increased interest and execution of Operations Other Than War (OOTW) missions around the world comes the need for simulating special missions in computer models. Such missions as Airfield Seizure, Hostage Rescue, and Noncombatant Evacuation Operations have successfully been accomplished in Janus versions 4.2 and 5.0 using VAX and UNIX operating systems. These missions required replicating interior building clearing, individual mines and explosives, soldier level of training, area weapons effects from direct fire weapons, Rules of Engagement and fratricide with combatants and noncombatants.

Current capabilities and limitations: Janus does allow for buildings of various sizes, shapes, and densities but current versions of Janus do not explicitly allow for interior building clearing operations from room to room. Mines are portrayed as entire mine fields of one type, (e.g., all AT or AP) but not as individual mines and explosives. Soldier systems are usually portrayed with the same capabilities regardless of side or level of training. Area weapons effects come from indirect fire weapons only. Prior to Version 5.8, multiple sides (e.g., civilians, hostages, etc.) with unique Rules of Engagement and fratricide could not be explicitly gamed.

Leveraging current capabilities to overcome modeling limitations: The OOTW Scenarios mentioned above used a combination of data surrogations, manipulations and work-arounds to give the gamer and analyst greater realism, flexibility and human interaction with the scenario model.

Data Standards and Leveraging Technology for Organizing the Data; a U.S. Army M&S Overview

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The U.S. Army Modeling and Simulations environment promotes the development and adoption of data standards for use in models, simulations, and simulators throughout the Army. The benefits of such an endeavor are improved information sharing, increased interoperability, and greater efficiency. By applying these standards with existing data base management software and hardware technology, U.S. Army agencies have completed or are in the process of automating their data.

This automation effort specifically enhances the modeling and simulation community by maximizing information sharing; minimizing unnecessary application of information; providing improvement of control, consistency, and quality of information; ensuring accurate and timely information; and developing a data infrastructure which will allow M&S systems to be faster and easier to build, easier to maintain, and more credible.

82nd Airborne Division OPLAN Analysis - Planned Invasion of Haiti 1994

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During the deliberate planning process for their planned invasion of Haiti in the summer of 1994, the commander of the 82nd Airborne Division solicited support from the U.S. Army TRADOC Analysis Center - White Sands Missile Range (TRAC-WSMR), to use their combat simulation technology to assist them in analyzing, refining and validating the OPLAN. TRAC-WSMR formed a team consisting of military and civilian analysts and used the Janus simulation to represent and analyze the OPLAN. The commander was interested in the outcome of the various fights in each of the three brigade areas of operation and the development of tactical and operational insights into each fight. Representatives of the division G2 and G3 staffs provided the TRAC analysts with the data necessary to represent the OPLAN in Janus. The G2 provided the threat representation based on their IPB and the G3 provided the concept of the operation, map sheets and overlays for each of the three brigade areas of operation. Scenarios were

created in Janus that allowed for the combat interaction as specified in the OPLAN. As each scenario was played, the analysts carefully evaluated the cause and effect relationships in each of the battles and developed tactical and operational insights. These insights were important to the commanders and staffs for the purpose of validating planning figures, force apportionment, weapons allocation, synchronization and tactics. A detailed briefing and Janus battle playback was presented to the division and brigade commanders and their staffs two weeks prior to the invasion date.

Wednesday, 1515 - 1645

Hazard From Industrial Chemicals

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It can not be denied that forces may encounter toxic industrial chemicals in their military missions throughout the world. This presentation will review a recent study, and the criteria that were developed, to determine whether there is a threat from the release of industrial chemicals in a military situation. Chemicals of concern are identified and hazard management (detection, protection, and operations) will be discussed.

Hierarchically Echeloned Laydown Planner with Equipment and Renderings (HELPER)

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In keeping with the theme of this year's symposium, this 25-30 minute, unclassified, multimedia presentation, (video and PowerPoint, Slide Show), will show an application of technology designed to assist military analysts as they move between varying levels of analysis. Military analysts are required to develop consistent products for a customer base with widely varying information requirements and interests. The majority of their tools are developed to support analysis at a specific level of analysis or echelon of interest.

For example, models like TACWAR, CEM and THUNDER were designed to assist in the analysis of campaign and theater level issues. Unfortunately, all to often analysts using these tools are asked to provide answers that require models with much lower levels of aggregation and high levels of resolution. The same problem exists at the other end of the spectrum. Analysts working with Janus or RADGUNS find themselves trying to answer questions that should have used models with higher levels of aggregation and lower levels of resolution.

HELPER is being designed to assist military analysts as they wrestle with these types of problems. Utilizing 4th generation commercial-off-the-shelf (COTS) software and a graphical user interface (GUI) designed by military analysts. HELPER steps (or allows them to leap) through varying levels of analysis from engineering level applications like BRL-CAD to campaign and theater level type applications associated with that level of analysis. HELPER can be tailored to support training, planning or material acquisition.

Innovations in Field Artillery Force Structure

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The TRADOC Analysis Center conducted the support analysis for the Army Science Board to examine alternative artillery force structures for the near-term time-frame. The primary issue addressed by the study was how much artillery is required to provide the most effective level of support to a heavy maneuver division.

The analysis compared alternative systems for performing direct and general artillery support to maneuver forces engaged in combat. Operational analysis was conducted to evaluate each alternative's contribution to combat effectiveness. Primary modeling and simulation tools used in the study were the Vector-in-Commander (VIC) combat model and the Target Acquisition and Fire Support Model (TAFSM). Results of the study supported a major force restructuring decision by the Department of the Army.

Thursday, 0830 - 1000

Real Time Battlefield Analysis (RTBA):

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The United States Army Space & Strategic Defense Command (USASSDC) in Colorado Springs has developed an information age Tactical Operations Center (TOC) for Theater Missile Defense (TMD), which is generally referred to as the TMDTOC. The TMDTOC is capable of receiving tactical messages and information from a variety of sources and subsequently integrate them into a practical set of displays to facilitate the TMD coordinator's mission to support the Land Component Commander.

Simultaneously with Colorado Springs, USASSDC , Huntsville, has developed a software capability known as the TMD Synthetic Battlefield Environment (TMDSBE) which allows for testing the computer stations and training personnel operating the TMDTOC in a simulated battlefield environment. The TMDSBE meets DIS standards and both the TMDTOC and TMDSBE capabilities were demonstrated during the October AUSA convention while also supporting other Advanced Warfighter Experiments (AWEs). USASSDC plans to continue

providing support during AWEs and Theater CINC exercises such as Atlantic Resolve, and Ulchi Focus Lens.

The combined capabilities of the TMDTOC and the TMDSBE have placed USASSDC in a position which could allow real time battlefield support to the commander in a significant manner, for the information gathered by the TMDTOC can be relayed back to Huntsville where the data can be analyzed in a real time basis by subject matter experts. This results in specific suggestions in support of the field commander. Such suggestions could range from redeployment of sensors to defeat enemy counter measures, optimize sensor coverage to allow for terrain and weather nuisances, use more powerful data processors available to USASSDC Huntsville to perform identification of difficult objects by field experts, more precise debris or chemical contamination laydowns due to a missile intercept or payload delivery, and superior integrated force status maps to meet specific commander requirements. An added benefit is that weapon system performance could be evaluated at a later time for recommendations for product improvement programs.

Conducting Warfighting Experiments at the National Training Center

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An integral part of the Force XXI process is the advanced warfighting experiments (AWE) at the National Training Center (NTC). The intent of these experiments is to provide important quantitative and qualitative insights into proposed changes in doctrine, training, organization, leadership, materials, and soldiers (DTOLMS). RAND has conducted quantitative research at the NTC over the last decade, and has found that obtaining these insights is difficult in this complex environment. Two critical issues exist for AWEs conducted at the NTC. First, limitations in the NTC database, along with the statistical problems associated with a single "experimental" rotation, will limit the usefulness of the quantitative data generated in the warfighting experiment. Second, the NTC training environment further limits the usefulness of both the qualitative and quantitative data collected there.

To maximize the usefulness of these experiments, the author presents a methodology for selecting the right topics for experiments at NTC and shows how the analytic community plays a key role in the selection process. In addition, the author shows how the analytic community can utilize the data from the experiments to further analyze and quantify the concepts behind the experiments. Lastly, the author discuses how the high-stress training environment at NTC represents a significant source of data for Force XXI. These data can be used to determine how new equipment can potentially perform in combat and how to make current simulations more realistic, particularly in the area of command and control.

DIS User Requirements for Advanced Concepts and Requirements (ACR) Analysis

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The ACR modeling and simulation domain supports analysis, experimentation and exploration with new concepts and advanced technologies to develop requirements which will better prepare the Army for future operations. Two forms of ACR domain analysis are Battle Lab Warfighting Experiments (BLWEs) and Advanced Warfighting Experiments (AWEs). Current use of DIS in BLWEs and AWEs consists primarily of constructive simulations linked with some computer generated forces and live instrumentation. Modeling in support of BLWEs and AWEs is ordinarily done before and after live experimentation. This paper discusses simulation needs for the Division XXI AWE and Corps XXI AWE, and compares requirements for these AWEs with current capabilities and with other ongoing efforts such as the Defense Advanced Research Projects Agency (DARPA) Synthetic Theater of War (STOW) 97 project and other Army STOW exercises. After reviewing how Battle Labs currently do business, we examine plans for the near future, including the Battle Lab Reconfigurable Simulator (BLRSIM) and its place in ACR domain analysis, and outline how we would use DIS in the distant future for analysis to support development of Force XXI requirements.

Thursday, 1330 - 1500
Leveraging Hierarchical Scenarios for Analysis

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TRADOC develops and uses three levels of scenario tools in accomplishing its combat development mission. The three levels include theater, corps/division, and brigade/battalion scenarios. The theater scenarios provide the overarching strategic and operational views of the joint and combined operations in the theater of war. The corps and division level scenarios provide an operational and tactical look at specific corps and division operations within the context of the theater scenario. At the highest level of resolution, the brigade and battalion level scenarios portray the tactics, techniques and procedures used in tactical engagements occurring within the context of the corps and division scenarios.

Considerable opportunity exists to use these scenarios for various types of combat development analysis. Analysts frequently use the multiple levels of scenarios to evaluate materiel system requirements, such as new helicopters or new armored vehicles. The hierarchy of scenarios finds less frequent, but

important use, in development of new organizational concepts. Additional potential uses exist in doctrinal analysis. The area of information operations (to include command and control warfare) provides probably the most fertile area for use of hierarchical scenarios. Theater scenarios can describe the overarching information warfare concepts and expected effects from the strategic and operational view. Corps and division scenarios can portray specific tactical actions and reactions to information operations. At brigade and battalion level, the scenario provides the opportunity to evaluate the specific phenomena (jamming, destruction, signal intercept, etc.) used to accomplish the desired tactical and operational objectives of information operations. This paper describes specific examples of how the hierarchy of scenarios can be applied by analysts in information warfare and other doctrinal applications.

Longbow Countermeasures Assessment

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and Doug Mackey
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This paper describes the methodology and selected findings of a force-on-force vulnerability assessment. An interagency team is conducting a joint effort toward developing methodologies for incorporating countermeasures (CM) in force-on-force analyses. Initial efforts focus on the LONGBOW Fire Control Radar (FCR). Countermeasure methodologies have been incorporated into the CASTFOREM combat simulation model. To test the methodologies a TRADOC Deep Attack Scenario from the LONGBOW COEA was used to set the tactical situation and provide the flow of the battle. False target propagation effects were investigated using a parametric analysis technique. In this effort, a wide range of values for the FCR false targets per scan were examined to determine the effects. Model sensitivity to background clutter and radar cross-section were addressed similarly in a sensitivity analysis in which key parameters were systematically changed for different runs of the simulation. Force effectiveness in different combinations of smoke and stand-off jamming were also examined. In addition, the use of early warning and non-radar mode of operation for RED air defense as a counter measure were also explored.

Polling vs. Event-driven Computer Generated Forces (CGF) Architectures

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CGF systems depend on the management of many simultaneous tasks. This is accomplished using scheduling methods. The two most common methods are *polling* and *event-driven*. The polling approach processes all tasks on each simulation cycle. If a process has no work, control is returned. The event driven approach processes only tasks triggered by specific events. If there are no events to create work, control is never given.

As simulation technology advances, users expect to run larger applications with higher fidelity. Demanding simulations impede performance of even the fastest systems. Small improvements in efficiency can return significant gains in performance. In a CGF system, increasing demands due to the growing size and complexity of simulations require efficient software designs to ensure maximum performance. Some implementation methods are more efficient than others.

This paper presents a study using a control flow model of ModSAF Finite State Machines (FSM). The model consists of programs that simulate polling and event-driven versions of the ModSAF FSMs. The purpose of this study was to compare the two approaches as they relate to a CGF system and analyze the results to see which, if either, is more efficient. The main focus was on the FSM structure, because it is an important efficiency area in CGF systems.

Acoustics in Computer Generated Forces

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This paper presents a Computer Generated Forces sound model. It addresses production, propagation, and detection of sound waves, and supports sounds emitted from vehicles and aircraft. Implementation is in ModSAF and uses the technique of "line-of-sound." This modeling process answers, "Can this entity be heard?" much like "line-of-sight" for the engagement process answers, "Can this entity be seen?" To demonstrate, a scenario is played using sound cues as a trigger for task transition. A platoon of Blue infantry and Red T-72s are traveling perpendicular to each other towards a common point with a terrain feature blocking "line-of-sight." Upon hearing sound cues from the Red T-72s the Blue infantry move into a hasty defensive position.

WG 11 — SPECIAL OPERATIONS/OPERATIONS OTHER THAN WAR — Agenda

Chair: Greg Jannarone, Consultant
Cochairs: Rob Roberson, Argonne National Laboratory
Joel Parker, USSOCOM
Bob Holcomb, IDA
Colonel Terry Silvester, USAF Special Operations School
Bob Smith, ElectroSpace
LTC Jim Stover, USCENTCOM
Advisor: Ray Stratton, Lockheed Martin
Room: GIF, 152

Tuesday, 1030-1200
Role of Non-Lethal Technologies in Operations Other Than War
Julia Klare, Lexi Alexander, IDA

Logistics in Humanitarian Operations: RESTORE HOPE Revisited
Patricia I. Hutzler, DOD Logistics Management Institute

Tuesday, 1530-1700
Surface combatant Requirements for Operations Other Than War (OOTW)
Christopher M. Robbins, The Johns Hopkins University Applied Physics Laboratory

Alternative Multinational Force Capabilities for Operations Other Than War
Dr. William J. Sheleski, IDA

Wednesday, 0830-1000
Automated Mission Planning for Naval Special Warfare - (TRIDENT)
Steven M. Fetherman, Sanders, a Lockheed Martin Company

Special Operations Cost Benefit Analysis Model (SOCBAM), Major Darrall Henderson, USSOCOM

Wednesday, 1330-1500
Armored Ground Mobility System (AGMS) Study Using the Joint Tactical Simulation (JTS)
Major Darrall Henderson, USSOCOM

Modeling SOF Contributions in a Major Regional Contingency
Thomas S. Stewart, BDM Federal, Inc.

Wednesday, 1515 - 1645 .... **Funston Hall, Conference Room**

Special Operations Forces (SOF) Use of Mission Planning, Analysis, Rehearsal and Execution (MPARE) to Support Training, Exercises, and Military Operations (TEMO)
Mr. John Cox, USSOCOM

Thursday, 0830-1000
USSOCOM Weapons of Mass Destruction-Decision Support System (WMD-DSS)
Jim Peerenboom, Mary Ann Widing, Carlton Roberson, Argonne National Laboratory, and Kent Fontaine, CALIBRE Systems, Inc.

Force Requirements in Stability Operations
James T. Quinlivan, RAND

Thursday, 1330-1500
Panel: Unconventional Warfare and Covert Action: Future Requirements, Forms and Utility
Greg Jannarone, Moderator, Consultant, Ray Stratton, Lockheed Martin Corp., COL Ken Getty, USA, USAJFKSWCS
Larry Redmond, GTE, Government Systems

ALTERNATE: ***Results of USCINCPAC/Naval Postgraduate School Workshop on OOTW Analytic Models***
Maj Ross Roley, HQ USCINCPAC/J53 and Dr. Dean Hartley, Oak Ridge National Lab

WG 11 — SPECIAL OPERATIONS/OPERATIONS OTHER THAN WAR — Abstracts

Tuesday, 1030-1200
Role of Non-Lethal Technologies in Operations Other Than War

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Since the end of the Cold War, the United States has come to view military forces as the foreign policy instrument of choice in a variety of operations other than war, ranging from small-scale disaster relief and humanitarian assistance missions to large scale peace enforcement missions. Such missions have proven inherently ambiguous and often risky, particularly when the threat of civilian casualties and collateral damage has constrained the use of force. Non-lethal technologies, because they are intended to accomplish missions by means other than delivery of direct lethal force, promise to improve our capabilities in this area.

Non-lethal technologies potentially have broad application. The operational characteristics associated with individual technologies--range, area of coverage, nature and duration of effect, and delivery systems--vary widely. Since different missions have different requirements, the degree of variation among non-lethal capabilities increases the probability that at least one capability can meet a given mission's requirements.

Keeping these distinguishing characteristics in mind, this presentation examines the opportunities and limitations which non-lethals offer in the context of mission and operational concepts for operations other than war. It gives special consideration to concepts for crowd control, neutralizing combatants intermingled with non-combatants, and safe area defense. It concludes by outlining several potential pitfalls and barriers to technology development and by suggesting steps decision-makers should take to effectively integrate non-lethal capabilities into foreign policy analysis and operational planning.

Logistics in Humanitarian Operations: RESTORE HOPE Revisited

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Approved abstract unavailable at printing.

Tuesday, 1515 - 1645
Surface combatant Requirements for Operations Other Than War (OOTW)

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This report is an historical analysis of US Navy surface combatant participation in Operations Other Than War (OOTW from 1990-1994, as well as an analysis of what combat and non-combat capabilities surface combatants may require to participate in future OOTW. These analyses were conducted as part of the Surface Combatant-21 (SC-21) Force Architecture Study to determine the impact of these types of operations on US Navy surface combatant requirements.

This analysis shows that US Navy surface combatant participation in OOTW increased substantially beginning in 1990 and continued at relatively high levels through the end of 1994. Additionally, while the capabilities surface combatants require to participate in OOTW do not differ substantially from those needed for traditional wartime missions, there are some capabilities "unique" to OOTW which would be useful to surface combatants participating in these types of operations in the future.

Alternative Multinational Force Capabilities for Operations Other Than War

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This study, which was conducted for OSD PA&E and the Army DCSOPS, examines the resources that were applied to recent Operations Other Than War (OOTW) by US and allied military forces, as well as other organizations such as the United Nations, International Organizations, Non-Governmental Organizations, and Private Voluntary Organizations. The study analyzes the experience gained during recent peacekeeping, peace enforcement and humanitarian assistance operations, identifies a number of key findings, and proposes specific recommendations to maximize the probability of success of these operations while minimizing the adverse impact that these operations could have on the readiness of active and reserve military forces.

Wednesday, 0830-1000
Special Operations Cost Benefit Analysis Model (SOCBAM)

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To aide USSOCOM in allocating resources during the POM process, SOJ5-C, USSOCOM is developing the Special Operations Cost Benefit Analysis Model (SOCBAM). The model is a two phased decision support system which seeks to allocate limited resources among competing programs in an optimal manner. Phase one is a hierarchical assessment of program merit and phase two is the actual mathematical optimization which addresses constraints, objectives, and the operation environment surrounding USSOCOM's Strategic Planning Process (SPP) and the POM.

SOCBAM is a mixed integer, multi-objective goal program using GAMS (General Algebraic Modeling System) which seeks to balance two goals: Maximize the utility of competing programs and Minimize funding turbulence for programs during the POM years. SOCBAM promises to be an important tool for decision makers during the resource allocation phase of USSOCOM's Strategic Planning Process.

Automated Mission Planning for Naval Special Warfare - (TRIDENT)

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TRIDENT is developmental program to produce automated planning tools for the U.S. Navy SEALs. The primary tool is an automated version of the SEAL's systemic mission planning methodology - Phase Diagramming. The development is a continuation of efforts commenced in early 1992 as Special Operations Forces Planning And Rehearsal System Phase II (SOFPARS II). SOFPARS II was improved as a Early Entry Battle Lab program called Advanced Command & Control Enroute System (AC2ES) for the 18th Airborne Corps, and in early 1995 the initiative to focus on Naval Special Warfare - TRIDENT began. Modeling the many complex and data intensive elements was a formidable challenge for analysis and design. The prototype design described here integrates video, digital camera, mapping, charting, geodesy, imagery, intelligence, hydrography, bathymetry, mission and target analysis tools, and a maritime autorouter for Combat Swimmer calculations, and Special Boats and SDV route planning. The tools are set in a windows environment and provide hyperlinking of the a fore mentioned data to the Phase Diagramming process, and the mission analysis and planning tools. Initial operational tests indicate that the new maritime planning systems, named TRIDENT for the SEAL's badge, can significantly reduce the time of the mission planning cycle (by 50%), increase information integration, reduce inadvertent omission, produce a complete mission plan, and increase mission success.

<u>*Wednesday, 1330 - 1500*</u>

Armored Ground Mobility System (AGMS) Study Using the Joint Tactical Simulation (JTS)

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The purpose of the AGMS Study is to determine the operational effectiveness of candidate vehicles in various mission configurations for use by a Joint Special Operations Task Force (JSOTF) . The objectives are to evaluate the operational effectiveness of candidate vehicles, to produce effectiveness rankings for the vehicles, and to recommend the preferred alternative based on the analysis.

JTS is the model of choich for the Special Operations Command for high-resolution gaming. JTS is a man-in-the-loop, opposing force, mutisided (up to ten sides), interactive model. It is being used as part of the front-end analysis for the AGMS COEA to give insights to the Operational Requirements DocumentORD) . It allows for a multitude of vehicle performance characteristics, for comparative analysis in obstacle breaching, vulnerability, and lethality. These characteristics can then be evaluated using different types of terrain, levels of threat, and sensitivity excursions. JTS has the capability to portray night and adverse weather, fatigue, fratricide and jumpiness, peripheral acquisition, secondary suppression, and smoke.

The scenario for the AGMS STudy is mountainous terrain in an urban location. U.S. citizens are held hostage in a non-permissive entry environment necessitating a ground extraction. The Threat consists of police and paramilitary forces equipped with small arms, RPGs, and mortars.

The Measures of Effectiveness are mission success - the ability to rescue all the hostages safely, time of completion - there is a two hour mission window before the threat can respond with overwhelming strength, and friendly losses - the cost of performing the mission in terms of vehicle and personnel losses.

Modeling SOF Contributions in a Major Regional Contingency

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To assist USSOCOM in evaluating implications of program decisions and mission requirements, BDM has undertaken a project for SOJ7-C to incorporate selected SOF operations into combat simulation of a theater campaign in Korea. The effort builds on modeling for several government clients using BDM's METRIC model. METRIC is a stochastic joint force simulation that includes explicit play of ground, air, and naval forces as well as sensors, intelligence fusion, and C3 interactions.

Work in progress looks at Blue employment of Direct Action and Strategic Reconnaissance against Red forces and seeks to capture and document the impact on theater combat evolution. A variety of measures of effectiveness are being applied to analyze differences in combat dynamics and outcomes between SOF and non-SOF cases and between a pair of SOF excursions positing differing SOF force and mission assumptions.

SOF simulation includes insertion and ground movement of ODAs and SEAL teams, raids on selected high-value targets, contributions to Blue battlespace awareness, and cueing of conventional strike and interdiction assets. Preliminary methodologies also have been devised for assessment of Red SOF threats, Blue SOF foreign internal defense missions, and psychological operations. The presentation will focus on methodologies, MOEs, and analytical approaches.

Wednesday, 1515 - 1645 ..... **Funston Hall, Conference Room**

Special Operations Forces (SOF) Use of Mission Planning, Analysis, Rehearsal and Execution (MPARE) to Support Training, Exercises, and Military Operations (TEMO)

Mr. John Cox and CDR Diane Lee
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The objective of MPARE is to integrate and use constructive simulations, and computer based operational tools to enhance combat capabilities of SOF during training, exercises, and military operations (TEMO). MPARE can best be visualized as a series of three systems: Mission Planning, Simulations, and Simulators which are embedded and separated by C4I systems. The goal of MPARE is to provide SOF located throughout the world to have to have the necessary capabilities for collaborative and distributed mission planning, using simulations for analysis, and previewing/rehearsing plans prior to execution of these plans during TEMO.

During the past two years, USSOCOM has been a major user of the Common Operational Modeling, Planning, and Simulation Strategy (COMPASS) to provide SOF with the necessary tools for accomplishing MPARE. COMPASS has allowed our units to participate in several demonstrations and proof of concept during April, 1995 and in September 1995, as part of the Joint Warrior Interoperability Demonstration 1995 (JWID 95) SOF units were able to provide collaborative and distributed mission planning, analysis and preview/rehearsal capabilities to the Joint Special Operations Task Force (JSOTF) at the operational level as well as provide plans to the strategic and tactical levels.

This presentation will show live SOF collaborative and distributive mission planning; use of analysis tools for course of action (COA) analysis through a Modeling & Simulations Operational Support Activity (MSOSA); and a preview/rehearsal capability from several locations throughout CONUS . The mission planning systems to be used will be: the Naval Special Warfare Automated Mission Planning System (SWAMPS)/Tactical Air Mission Planning System (TAMPS); the Special Operations Forces Mission Planning and Rehearsal System (SOFPARS); and the Air Force Mission Support System (AFMSS). The simulations tools that will be used to analyze the plans will be provided by NraD's MSOSA located in San Diego. COMPASS will serve as the conduit for permitting mission planning, simulations, and preview/rehearsal capabilities to be shown.

Thursday, 0830 - 1000

USSOCOM Weapons of Mass Destruction-Decision Support System (WMD-DSS)

Jim Peerenboom, Ms Mary Ann Widing, Mr Carlton Roberson
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Bldg 900, Room P-21
Argonne, IL 60439
PH/FAX: (703)845-1000/845-1117

Mr Kent Fontaine, CALIBRE Systems, Inc.
CALIBRE Systems, Inc
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The briefing will discuss the United States Special Operations Command's (USSOCOM) Weapons of Mass Destruction-Decision Support System (WMD-DSS) project. The WMD-DSS is to provide special operations forces (SOF) personnel with a graphically-oriented decision support system that can be used to: graphically display the relationships among the government agencies and other organizations ("participants") that would be involved in WMD-related activities; identify the demonstrated capabilities, limitations, and documented authorities and responsibilities of those participants; identify information required by selected participants on the basis of specific scenario circumstances; identify the potential risk of selected actions/non-action; and provide an easily accessible database of reference documentation applicable to WMD scenarios and the participants' organizations structures, authorities and responsibilities.

Force Requirements in Stability Operations

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Military requirements for the post-Cold War environment are the central question of a large, somewhat disorganized, debate. Conducting frequent and extended "peace operations" requires a serious effort to understand the political context and their military requirements. This paper investigates the numbers of "peace keepers" required for stability operations, both for entire countries and individual cities, and explores the implications for those numbers for deployment, rotation, readiness, and personnel retention.

ALTERNATE

Results of USCINCPAC/Naval Postgraduate School Workshop on OOTW Analytic Models

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Dr. Dean Hartley
Oak Ridge National Lab
1099 Commerce Park
Oak Ridge, TN 37830
423-574-7670

This paper describes the results of a workshop held in February 1996 on analytic modeling for Operations Other Than War (OOTW). Organized by USCINCPAC and hosted by NPS, the primary purpose of the workshop was to establish a road map for developing analytic tools for OOTW. Although many analytic models exist for conventional warfare, and a handful of training

simulations are available to assist in OOTW, few analytic models have been designed for OOTW. This workshop was the first step in filling the void.

The workshop consisted of briefings, plenary sessions, and working groups. The end result was two products: joint modeling and simulation requirements, and possible solutions to address the void in OOTW analytic models and tools. Discussions concentrated on operations below a Major Regional Contingency and above normal peacetime engagement.

Most experts believe the US military will be conducting OOTW missions with increasing frequency in the 21st century. Analytic tools must be developed to provide OOTW decision makers with a structured process and meaningful data upon which to base their decisions. We believe this workshop provided the basis for significant efforts to develop OOTW analytic models.

WG 13 — ELECTRONIC WARFARE AND COUNTERMEASURES — Agenda

Chair: LtCol Tom White, AFIWC/SAA
Co-chairs: Prof Fred Levien, NPS
Terrence Cronin, LEWD
Nicholas J. Basciano, ARINC
Advisor: Jim Oliver, AFIWC/SA
Room: GIF, 353-D

Tuesday, 1030 -1200
Levering Signature Measurement and Data Base Technology for the Electronic Warfare Analyst
Lt Col Richard Barker, Office of the Secretary, Joint Tactical Missile Signatures

Optimizing Vehicle and Fleet Survivability for the Crusader System
Dr. Roy E. R ice, Teledyne Brown Engineering

Tuesday, 1530 -1700
Infrared Missile Engagement Modeling and Simualtion Vision
Major Seth D. Shepherd, Air Force Information Warfare Center Systems Analysis Directorate

Representing Information Warfare in a Corps-Level Combat Model
Lt Col Robert S. Alexander, USA Concepts Analysis Agency

Wednesday, 0830 -1000
A Survey of Text Search and Retrieval Technology
Paul Brodnicki, Director, Advanced Systems, Calspan Advanced Technology Center

Mission Date Development, a Joint-Service Technical Approach
Jerry D. Sowell, Technical Advisor, 53WG/68ECG/36ETS/EEA

Wednesday 1330 -1500
COMPOSITE GROUP III SESSION .... **Bell Hall, Marshall Auditorium**

Wednesday 1515 -1645
A High Efficiency, Broadband, HF Wire Antenna Network
Mr Daniel D. Reuster, PH D., ARINC

The Elusive Target of Command and Control Warfare: The Decision Making Process
Lt Cummings, Scientific Analyst, AFIWC/SAA

Thursday, 0830 - 1000
Nonparametric Jammer Flight Testing Using the TrueStat Statistical Software Package
Mr Shawn Spencer, Chief, Communication Computer Flight, 513 Engineering and Test Squadron/EENA

WG 13 — ELECTRONIC WARFARE AND COUNTERMEASURES — Abstracts

Tuesday, 1030 -1200
Levering Signature Measurement and Data Base Technology for the Electronic Warfare Analyst

Lt Col Richard Barker
DoD Implementation Director
Office of the Secretary, Joint Tactical Missile Signatures
Phone: (210)671-1905

Throughout military history, significant numbers of combat casualties have been attributed to limited warning of impending attack. Recently during the Iraqi war, 90% of aircraft losses were the result of "silent" missiles. Additionally, undetected missiles have damaged ships (USS STARK), destroyed countless armored land vehicles (Iraqi losses due to US Maverick, Hellfire, and TOW missile), and also accounted for 35% of US friendly fire kills during the Iraqi conflict. To respond to this threat, DoD employs sophisticated missile warning systems (MWS), many of which require detailed missile signature data to operate correctly. To develop systems capable of both detecting and countering present and future generations of passive missile threats, developmental and operational communities will require greater quantities and greater quality missile signature information.

JTAMS, a joint test force (JTF), has focused on measurement process improvements to acquire high quality infrared (IR) an ultraviolet (UV) engineering data on tactical missile plumes. The

intent of his process is to ultimately enhance the development of future passive missile warning receivers and countermeasures systems. Many functional areas stand to benefit as a result of JTAMS program objectives and the tactical missile signatures (TMS) data standardization approach developments. Technology (JTF developed products) transfer tasks are proposed to promote the JTF's vision for effective DoD acquisition and dissemination of TMS data.

JTAMS produced its major products with an understanding of how an understanding of how each product relates to weapon system development activities. Validated threat information is important to Cost and Effectiveness Analyses (COEA) which may vary from a large force-on-force to a detailed engagement scenario, and also for the Test and Evaluation Master Plan (TEMP) where integrated analysis tools and a signatures database can aid in forming an analytical baseline for assessing measures of effectiveness. Once JTAMS technology is transferred to existing DoD organizations, and its database functions are integrated with various collection and modeling activities, the many functional groups with the TMS community will leverage each other's strengths to work towards better measurement planning, sharing of signature information, improving electronic warfare database, and sponsoring most cost effective signature data collection and modeling development tasks.

Optimizing Vehicle and Fleet Survivability for the Crusader System

Dr. Roy E. Rice, Teledyne Brown Engineering
P.O. Box 070007
Huntsville, AL 35807-7007
Phone: (205)726-2038

Combat vehicles will face a wide array of threats on the future battlefield. To counter these threats, we must design treatments and countermeasures into these vehicles that will negate these threats and enhance the probability of survival. These survival measures cover the spectrum of technology from signature management to improved armor to threat warning systems. But each of these measures carries a set of burdens. These burdens are in terms of additional weight, Cost, volume, power, etc. The problem our requirements analysts and designers face is a classic Knapsack Probe. We have knapsack that is only so big and can only carry so much "stuff." Our approach and the solutions are
driven by threat that we are likely to encounter. We solve this knapsack problem using a Mixed Integer Program (MIP) which maximizes the probability of survival of a single vehicle in a single expected encounter. The decision variable are which countermeasure treatments to include in the suite being designed into the vehicle to counter the threat. To maximize survivability the model chooses treatments that can counter the specific threats according to quantitative measures of how effective the treatments are at countering the threats. The assignments of the treatments are chosen so that the resulting suite does not exceed established limits on cost, weight, volume, data, and power parameters.

Tuesday, 1530-1700

Infrared Missile Engagement Modeling and Simulation Vision

Major Seth D. Shepherd, Air Force Information Warfare Center, Systems Analysis Directorate
AFIWC/SAC; 102 Hall Blvd, Suite 342
San Antonio, TX 78243; Phone: (210)977-2391

This paper describes a vision for a flexible fidelity modeling and simulation (M&S) architecture to satisfy all DoD IR M&S requirements. Infrared (IR) missile engagement modeling and simulation uses include tactics development for aircrews flying in threat environments, flight-test planning, design of IR countermeasures and determining budget priorities. Depending on the application, a range of model fidelity and simulation run-time may be required. Existing models only provide a choice between high model fidelity with slow simulation run-time or a low fidelity model with fast simulation run-time. As a result, some customer's needs are not met. Current DoD policy indicates the future modeling and simulation development will occur within the Joint Modeling and Simulation System (J-MASS) architecture. Under this architecture, an IR missile engagement simulation will involve interaction of specific objects: a missile seeker object, a target object, countermeasure objects, atmosphere object, and so forth. J-MASS is projected to be used by analysts across DoD. It is therefore vitally important to ensure objects and their interactions are created for maximum utility. A sound design of IR engagement objects and architecture would create the capability to have flexible model fidelity and run-time. This design would allow the analyst to choose a suite of objects that together would meet his/her particular run-time and fidelity constraints.

Representing Information Warfare in a Corps-Level Combat Model

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Phone: (301)295-5259

Of the three types of combat simulation, virtual, real, and constructive, only constructive simulation is as yet widely used and well understood with respect to its valid uses for analysis of combat operations. Therefore, as simulation technology grows more exotic with the development of distributed interactive simulation, traditional constructive combat models are likely to remain a very important tool for analysis of force structuring, combat developments, contingency planing, and many other issues.

At the same time, it is widely believed that very nature of combat is changing because of the impact of information technology. But representation of information warfare in constructive models is not fully developed, especially in aggregated models. It is imperative, therefore, that continuing research be conducted aimed at better representing combat operations of the future.

Work being done at United States Army Concepts Analysis Agency using the combat model Eagle is addressing the representation of information warfare at the operational level of combat. The effects of digital sensor-to-shooter links, intelligence fusion, command and control technology (specifically the Army Tactical Command and Control System, or ATCCS), and digitization of the battlefield were all modeled in Eagle scenarios used to support the biennial capital budgeting study "Value Added Analysis". In this presentation, the schemes for representing these various information warfare functions are discussed. This first use of Eagle in a major analytical effort demonstrated that Eagle promises to be a useful tool for understanding the future of combat operations in the context of Force XXI initiatives and issues.

Wednesday, 0830-1000
A Survey of Text Search and Retrieval Technology

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Approved abstract not available at printing.

Mission Date Development, a Joint-Service Technical Approach

GM-14 Jerry D. Sowell, Technical Advisor
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Defines Mission Data (MD) for EC systems and discusses the advantages of conducting ground characterizations of threat radar's to support MD development. Addresses the reduction in costs and increase in technical data obtained as compared to flight testing. Describes the difference in ground characterization with the respect to the USAF EC Test Process of Modeling and Simulation. Presents the benefits of conducting this type of MD development as a multi-service effort. Discusses the operational impact of using ground mount technical data to support MD development.

Wednesday 1330-1500
COMPOSITE GROUP III ..... Bell Hall, Marshall Auditorium

Wednesday, 1515 - 1645
A High Efficiency, Broadband, HF Wire Antenna Network

Mr Daniel D. Reuster, PH D., ARINC
ARINC, 2551 Riva Rd
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ARINC's previous customer support in the area of HF antennas has shown that longwire HF antennas used to cover the entire HF band (3-30 MHz) require the use of complex impedance matching networks to keep the VSWR low across the band. These matching networks can be either passive or actively tuned; both have their limitations. Passive matching networks are typically inefficient due to the difficulty of impedance matching over such a large range of frequencies. Actively tuned networks impose limitations on the type of transmissions possible from such systems. through ARINC's analyses, typical efficiencies for longwire HF antennas have been found to be on the order of 10-20%. As a result, ARINC has investigated possible methods of improving the efficiency for this type of antenna system..

ARINC has numerically designed a two-wire trapped antenna system design for the 1-30 MHz frequency range. The intent of the antenna system is to provide continous RF coverage over the 3-30 MHz range while maintaining maximum antenna gain and stable input impedance. The antenna design utilizes ARINC's patent pertaining to banded impedance matching in conjunction with choked antenna technology to create a high efficiency antenna system. The enhanced efficiency antenna system utilizes two long wires to achieve coverage over the entire HF band using alternating sub-bands. The individual wires are subdivided into sections through inductive/capacitive traps. There are two such traps placed on each wire which allows for six different quarter wavelength antennas. This is possible since the traps serve to limit the current flowing in the wires at certain frequencies allowing the antenna system to electrically adjust it's effective length such that it always appears to have an electrical length of approximately one quarter wavelength. In essence, the longwire system is broken up into six quarter wavelength antennas by the use of properly spaced traps.

ARINC envisions installing its current design on various military vehicles. The prototype, two wire antenna design is expected to produce gains of at least 0 dBi and main efficiency levels between 60 and 85%. The prototype antenna will also be capable of transmitting six signals (one in each band simultaneously.

The Elusive Target of Command and Control Warfare: The Decision Making Process

David Cummings, Lt, USAF
Scientific Analyst
Air Force Information Warfare Center Systems Analysis Directorate
102 Hall Blvd Ste 342
San Antonio Tx 78243; Phone: (210)977-2391

As we broaden our perspective from Electronic Warfare to Command and Control Warfare (C2W), we encounter unfamiliar methods of waging war--namely, Psychological Operations, Tactical Deception and Operational Security. Rather than focusing on a physical asset, these methods target the decision making process. Therefore, it is critical for us to understand human decisions in order to model the effects of C2W on the enemy's warfighting capability. In our example of an Integrated Air Defense System (IADS), we highlights the pivotal role of human decisions at all levels. We discuss our present weakness in modeling the decision maker, as well as difficulties which arise in testing the validity of decision models. We present our experience in an operational (man-in-the-loop) IADS test, demonstrating the inherent problems in understanding the human decision process.

Thursday, 0830 - 1000
Nonparametric Jammer Flight Testing Using the TrueStat Statistical Software Package

Mr. Shawn Spencer, Chief, Communications Computer Flight
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103 E. Mission Ave; Bellevue NE 68005-5220

Testing jammer aboard aircraft while in flight is very expensive. Since budgets are not unlimited, sample sizes are usually very small. Since the distribution of the data is unknown and the sample sizes are small, nonparametric statistics are desired.

To test the performance of the jammers two types of aircraft positions are recorded. The actual position of the aircraft and the perceived position of the aircraft from threat simulators. The difference between these two positions is tracking errors.

The data is then categorized and tested for differences. An example of two types of categories could be when the jammer was off and when the jammer was off and when the jammer was on. The difference between these two categories would be the ability of your jammer. We have created a software package called TrueStat that uses two sets of data and calculates parametric and nonparametric statistics.

TrueStat is an extremely user friendly windows driven statistical package written in Foxpro and C++. It compares two samples of any size and three confidence levels using the Student's t-test and the Mann-Whitney test statistic. It also calculates basic statistics and performs a Lilliefor's test for normality. Along with these results it also calculates a p-value.

The package is supplied on two 3.5 diskettes and is a stand alone program that can be used on a minimum of a 386 with a 640X480 resolution screen and 8Mb of memory for windows and 2Mb for the program. Future modifications will include a help file, improved processing speed, and accommodate binomial data.

WG14 — JOINT CAMPAIGN ANALYSIS — Agenda

Chair: Richard P. Morris, McDonnell Douglas Aerospace
Cochair: Jeff Paulus, General Research Corporation
Cochair: Bill Burch, Integrated Systems Analysts
Advisor: James Wilmeth, SETA Corporation
Room: GIF, 360-A

Tuesday, 1030-1200
JWARS Role in Joint Analysis
LTC Terry W. Prosser, Deputy Director, JWARS Office

Campaign Analysis Supporting The Joint Force Air Component Commanders (JFACC)
Balf B. Callaway, ACC/XP-SAS

Tuesday, 1530-1700
Getting Inside the Acquisition Decision Investment Cycle
LtCol John J. Gill, ESC/XRP

COMPASS Lessons Learned in Support of Joint Air Campaign Analysis
CDR Daniel R. Donoghue, NCCOSC RDT&E Division, COMPASS Project Manager

Wednesday, 0830-1000
CINC Panel . . . . **GIF, Dupuy Auditorium**

Wednesday, 1215-1300
Methodology for Quantifying Foreign Ground Force Performance Factors
Gerald A. Halbert, NGIC

Wednesday, 1330-1500
COMPOSITE GROUP III SESSION . . . . **Bell Hall, Marshall Auditorium**

Wednesday, 1515-1645
Where the Rubber Meets the Road: Implementing Joint Data Support for JAMIP
Dr. Susan Marquis, OSD/PA&E, Director, Planning and Analytical Support Division

Joint Strike Fighter Requirements
Capt Laurie Rouillard, Joint Strike Fighter Program

Thursday, 0830-1000
82nd Airborne Division OPLAN Analysis - Planned Invasion of Haiti 1994
LTC John R. Ferguson, U.S. Army TRADOC Analysis Center, Study Director

Warfighting Analytical Support to Third US Army (WAS-TUSA)
LTC Wm Forrest Crain, U.S. Army Concepts Analysis Agency

Thursday, 1215-1300
Victory Misunderstood: Skill, Technology and What the Gulf War Really Tells Us About the Future of Conflict
Dr. Stephen Biddle, IDA

Thursday, 1330-1500
Concept of Operations for ATO Analysis Using TMS and ACAAM
Dave Anderson, GDE Systems, Inc.

Joint Consistency Issues in Multi-Service Campaign Analysis
Van Cunningham, HQ U.S. Army, ODCSOPS

Tuesday, 1030-1200
JWARS Role in Joint Analysis

LTC Terry W. Prosser
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Phone: (703) 602-2917

This presentation will discuss the types of studies JWARS is intended to support and how the model is being developed to support each.

The presentation will include a brief background description of typical analytic objectives of DoD studies, JWARS functionality required to address those objectives and an overview of the JWARS development approach. Detailed discussion will center on the JWARS prototype as an example of how JWARS will support joint analysis. Additionally, the presentation will address key aspects of the pre- and post-processing functions required to support the analyst.

The presentation will conclude with a brief discussion of JWARS' future development plans.

Campaign Analysis Supporting The Joint Force Air Component Commanders (JFACC)

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Shortly after the 1994 release of the ACC Two Major Regional Contingency (2 MRC) Study, ACC/XP-SAS received requests from 7th and 9th Air Force to examine current planning in their respective theaters. The Southwest Asia and Northeast Asia data bases were completely repopulated using the most current intelligence data available. Existing guidance including Operational Plans, Air Tasking Orders, Time Phased Force Deployment Lists (TPFDLs), and inputs from theater air campaign planners, was used to establish baselines for each of the theaters. The baselines were then used to do extensive analysis of variations in force arrivals, force applications, threat strengths and warning times. COMBAT IV, a deterministic campaign model, was chosen due to its responsiveness. Results of this analysis influenced timing and sequence of air assets in the TPFDLs. The baselines were later used to evaluate changes in Flexible Deterrent Options and Air Campaign Plans. These studies, along with SAS's current commitments, responsive data bases, and on-going efforts, have institutionalized a close working relationship providing analysis to support the theater JFACCs.

Tuesday, 1530-1700
Getting Inside the Acquisition Decision Investment Cycle

LtCol John J. Gill
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Phone: (617) 377-6554

As Electronic System complexity increases, acquisition decisions become more dependent on the results provided by constructive models and joint simulations. Questions that are now becoming paramount deal with the issues of confidence in the modeling processes and the results they produce. Is either the constructive models or joint simulation process sufficient for making effective decisions? Is there an appropriate balance between these two processes? What are the similarities that might be the foundation of effective and timely decisions? These and others are practical considerations to be discussed based upon the author's experiences contributing to the Joint Surveillance Targeting and Attack Radar System (JSTARS) and Joint Tactical Information Distribution System (JTIDS) Cost and Operational Effectiveness Analyses (COEAs). Insights into fostering interservice cooperation for accurate analysis and data sharing are provided. Are we really getting our money's worth?

COMPASS Lessons Learned in Support of Joint Air Campaign Analysis

CDR Daniel R. Donoghue
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San Diego, CA 92152
Phone: (619) 553-1772

This presentation will focus on lessons learned from Common Operational Modeling, Planning and Simulation Strategy (COMPASS) project demonstrations, exercises, and operations in support of air campaign planning analysis by joint service warfighters. COMPASS is the Defense Modeling & Simulation Office (DMSO) sponsored project, which has developed non-intrusive middleware for integration into Command, Control, Communications, Computers, and Intelligence (C4I) and M&S systems to facilitate distributive collaborative planning, mission preview, and Distributed Interactive Simulation (DIS) based rehearsal in support of air campaign planning. The COMPASS project supports the DMSO C4I to Simulation Initiative, to make M&S collaborators in the operational planning process. In 1994, DMSO designated the Naval Command, Control and Ocean Surveillance Center Research, Development, Test & Evaluation Division (NCCOSC RDT&E DIV) as Project Manager for COMPASS as an advanced technology demonstration project with joint service orientation and applicability.

This presentation will include videotape highlights of USSOCOM-COMPASS Demonstration, conducted for Special Operations Forces Commanders with participation from six dispersed sites; and JWID 95-COMPASS Demonstration, included 16 participating sites and 13 COMPASS capable C4I/M&S systems. COMPASS capable systems include: (1) Air Courses of Action Assessment Model (ACAAM), (2) Air Campaign Planning Tool (ACPT), (3) Air Force Mission Support System (AFMSS), (4) Air Warfare Simulation (AWSIM), (5) Coordinated Adaptive Planning System (CAPS), (6) Contingency Theater Automated Planning System (CTAPS), (7) Extended Air Defense Simulation (EADSIM), (8) Force Level Analysis and Mission Effectiveness System (FLAMES), (9) Interactive Tactical Environment Management System (ITEMS), (10) Navy Modular Semi-Automated Forces (ModSAF), (11) Special Operations Forces Planning and Rehearsal System (SOFPARS), (12) Tactical Air

Mission Planning System (TAMPS), and (13) What If Simulation System for Adv. R&D (WISSARD).

Wednesday, 0830-1000
CINC Panel .... GIF, Dupuy Auditorium

Wednesday, 1215-1300
Methodology for Quantifying Foreign Ground Force Performance Factors

Gerald A. Halbert,
National Ground Intelligence Center (NGIC)
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Charlottesville, VA 22902
Phone: (804) 980-7560

The intelligence community has been fairly successful at providing information to users on the composition of unit strengths and performance characteristics of ground forces equipment. Other "soft" factors quantifying how well a country's armed forces will perform on the battlefield has always been placed in the "too-hard-to-do" category.

The National Ground Intelligence Center has a methodology that evaluates factors such as logistics, maintenance, leadership, capability to conduct combined arms operations, capability to conduct joint or combined force activities, and training (among others) to assist in quantifying how well countries may use equipment on the battlefield. This methodology ranks these factors into levels of performance. The levels are not linear but represent a ranking of capabilities, from the lowest to the highest. We make these performance factors evaluations from the present out 10 and 20 years.

Application of this methodology requires further refinement to convert ranked performance levels to input data usable by the modeling community. This can only be accomplished by an intensive dialog between the intelligence and modeling communities. Warfighters can use this information for operational planning, and troop information. These rating factors are the first step to answering the question, "how good are those guys?"

Wednesday, 1330-1500
COMPOSITE GROUP III SESSION
Bell Hall, Marshall Auditorium

Wednesday, 1515 - 1645
Where the Rubber Meets the Road: Implementing Joint Data Support for JAMIP

Dr. Susan Marquis, SES, Director
Planning and Analytical Support Division
1800 Defense Pentagon, Room 2D279
Washington, DC 20301-1800
Phone: (703) 695-7945

The Joint Analytic Model Improvement Program, following approval and direction by the Deputy Secretary of Defense, kicked off in September of 1995. Critical to the success of JAMIP is the design and implementation of the Joint Data Support System (JDSS). Joint Data Support is tasked to provide information and data to theater-level analytic models, including those in the "current suite" of models (e.g. TACWAR, VIC, MIDAS, and EADSIM) and the new Joint Warfighting System (JWARS). After months of developing and briefing the Joint Data Support concept, we have reached the reality of implementation. This briefing provides an update on the status of the Joint Data Support System and offers insights and "lessons learned" in the process of moving from concept to an operational system providing authoritative, scrubbed, model-ready data to the broad DoD-wide analytic modeling community.

Joint Strike Fighter Requirements

Capt Laurie Rouillard
Joint Strike Fighter Program
1745 Jefferson Davis Hwy, Suite 307
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The Joint Strike Fighter Program is an acquisition reform program to facilitate development of fully validated and affordable operational requirements; facilitate maturation of leveraging technologies; demonstrate leveraging technologies and operational concepts; and develop and deliver products and processes to initiate follow-on EMD program(s) to enable successful development and production of next generation strike weapons systems for the U.S. Navy, U.S. Marine Corps, U.S. Air Force, and our Allies.

Early involvement of warfighters facilitates development of validated and affordable operational requirements. Warfighter involvement is achieved through two groups, a national group of warfighting operators and logisticians from the three services called the Force Process Team (FPT) and a subgroup of doctrinal service requirements officers called the Operations Advisory Group (OAG). The OAG and FPT participate in interactive wargames at the campaign level using the THUNDER model to capture CONOPS and best use of force. From the wargames scenarios for Southwest Asia, Northeast Asia, and the Generic Composite Scenario strike warfare deficiencies for 2010 and beyond were identified in a Joint Mission Area Analysis.

This paper and presentation will cover the JSF campaign analysis to date and discuss how JSF has leveraged an industry and government team via a secure network that permits distributive analysis in the wargaming process. The first proof of concept was the wargame conducted at the Kirtland AFB in April 1995. At this game all players were at Kirtland but processing was done at both Kirtland and Patuxent River Naval Air Station via the secure network. The next wargame at Edwards AFB will be distributed with some analysts remaining at their home organizations but using the secure network to provide support to the wargame.

Thursday, 0830-1000
82nd Airborne Division OPLAN Analysis - Planned Invasion of Haiti 1994

LTC John R. Ferguson
U.S. Army TRADOC Analysis Center - White Sands
ATRC-W
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During the deliberate planning process for their planned invasion of Haiti in the summer of 1994, the commander of the 82nd Airborne Division solicited support from the U.S. Army TRADOC Analysis Center - White Sands Missile Range (TRAC-WSMR), to use their combat simulation technology to assist them in analyzing, refining and validating their OPLAN. TRAC-WSMR formed a team consisting of military and civilian analysts and used the Janus simulation to represent and analyze the

OPLAN. The commander was interested in the outcome of the various fights in each of the three brigade areas of operation and the development of tactical and operational insights into each fight. Representatives of the division G2 and G3 staffs provided the TRAC analysts with the data necessary to represent the OPLAN in Janus. The G2 provided the threat representation based on their IPB and the G3 provided the concept of the operation, map sheets and overlays for each of the three brigade areas of operation. Scenarios were created in Janus that allowed for the combat interaction as specified in the OPLAN. As each scenario was played, the analysts carefully evaluated the cause and effect relationships in each of the battles and developed tactical and operational insights. These insights were important to the commanders and staffs for the purpose of validating planning figures, force apportionment, weapons allocation, synchronization and tactics. A detailed briefing and Janus battle playback was presented to the division and brigade commanders and their staffs two weeks prior to the invasion date.

Warfighting Analytical Support to Third US Army (WAS-TUSA)

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Today's technology conceptually places many analytical tools literally in the warfighting commander's ruck sack. From deployment analysis to analysis and comparison of courses of action - computer assisted warfighting analytical support is here and now. A joint effort between the Third US Army (TUSA)/US Army
Central Command (ARCENT) and the US Army Concepts Analysis Agency (CAA) has made this concept a reality. The program is designed to provide deployable, on-site, responsive, real time analytical support capability for the planning and conduct of combat operations. After initial testing at ROVING SANDS (April 1995), this capability was deployed and fully incorporated with ARCENT headquarters during BRIGHT STAR 95.

CAA has formed a deployable analytical support team (DAST) consisting of two officer analysts/operational planners, equipped with a deployable analysis support package consisting of laptop computers with FAX modems, printers and appropriate software. The team has stand-alone combat simulation and analysis capability as well as the capability to link back to CAA in order to gain access to all the analysis, modeling, and simulation capabilities of the agency.

During BRIGHT STAR 95 exercise, the team demonstrated this analytical support capability with resounding success. ARCENT integrated this support capability to examine courses of action during process, project branches and sequels to ongoing operations and to serve as a command post exercise (CPX) driver. The DAST typically was able to take a course of action from the ARCENT planners, conduct pre-processing - combat simulation - and post processing analysis, and provide a presentation quality decision graphics brief in 2-3 hours. WAS-TUSA has clearly placed the warfighting analytical support capability in the operational commanders ruck sack.

<u>*Thursday, 1215-1300*</u>

Victory Misunderstood: Skill, Technology and What the Gulf War Really Tells Us About the Future of Conflict

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The standard explanations of the Gulf War's outcome are wrong. A combination of new information and the results of counterfactual analysis using new computer simulation techniques undermines both the orthodox view (that new technology was chiefly responsible for the war's one-sidedness) and its main rival (which emphasizes Iraqi shortcomings, not U.S. strengths). Instead, I propose a new explanation based on the interaction of new weapons and Iraqi mistakes. That is, Iraqi errors created opportunities for new U.S. technology to perform at proving-ground effectiveness levels and sweep actively resisting Iraqi Republican Guard units from the battlefield. Without the Iraqis' mistakes to provide openings, however, the outcome would have been far different in spite of our technology -- and U.S. casualties would likely have reached or exceeded prewar expectations. But without the new weapons, mistakes like the Iraqis' would not have enabled us to prevail with the historically low losses of the Gulf War. Many previous armies have displayed combat skills no better than theirs, but without producing results anything like 1991; only a powerful interaction between skill imbalance and new technology can explain the difference. This new explanation has policy implications for theater campaign assessment, force planning, weapon system evaluation, and defense spending priorities. But it also challenges a more sweeping legacy of the war: the new orthodoxy that we are embarked upon a "revolution in military affairs." This thesis holds that precision air and missile strikes will dominate future warfare, and that the struggle for information supremacy will replace the breakthrough battle as the decisive issue for success. I argue that this view is based on a fundamental misreading of the war, and that a proper understanding implies a very different pattern for the conflicts of the future.

<u>*Thursday, 1330-1500*</u>

Concept of Operations for ATO Analysis Using TMS and ACAAM

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This paper describes a concept of operations for using two available government-owned mission plan analysis systems, the Targeting Management System (TMS) and the Air Courses of Action Assessment Model (ACAAM), to perform Air Tasking Order (ATO) analysis. Those systems can be used together to assist in ATO analysis in both deliberate and crisis action planning.

TMS is a software application that facilitates the entry, manipulation, and use of targeting and weaponeering information to develop Joint Target Lists (JTLs). TMS provides the ability to create target lists, attach aimpoints to targets, apply weaponeering solutions to aimpoints, and to view/edit target lists associated with the ATO. The TMS system then distributes the completed target "catalog" to other mission planning support systems such as ACAAM.

ACAAM is a computer-aided analytic tool that examines options for Joint Theater tactical air operations. The model was developed as an integrated package capable of evaluating damage expectancy to the enemy target set and strike force vulnerability. Key features of ACAAM used in ATO analysis are its unique automated route development and air strike force-on-force Monte Carlo simulated mission assessment capabilities.

These two mission planning support systems have been used in conjuction successfully in USPACOM during FY-95/96 to assist air strike planning analysts in executing essential roles within the Crisis Action and Deliberate Planning Procedures. ATOs that are generated externally can be electronically read into TMS, assigned nominal or user-developed weaponeering solutions and electronically exported to ACAAM to determine feasible, low-cost routes to targets, and to estimate ATO results. Analysis results can also be remotely displayed to operational commanders.

Joint Consistency Issues in Multi-Service Campaign Analysis

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As more joint campaign analysis is done to facilitate the assessment of cross-service requirements and resources, it is more important that the greater DoD analytical community treat employment of Service assets realistically and consistently. Experience shows several areas of inconsistency and some parochialism. This paper raises several areas where conflicting views have surfaced. Future analysis should draw from the solutions found. Other future work may resolve some of the issues previously experienced but not resolved. In the interest of fair, conscientious analysis, these issues and their implications need to be opened to the analytical community and resolved in the light of day. These issues include:

- Service tactical operations across operational phases
- Weapon system employment and effects
- Weapon system costing
- Power projection issues related to employment of units in theater
- Suggestions to increase understanding of joint and Service operations

WG 15 — SPACE/C3I — Agenda

Chair: Dr. William Kemple, NPS
Co-chairs: Ed Cesar, Consultant
CPT Robert Claflin, USA, TRAC
Zach Furness, MITRE
Advisor: Donald W. Kroening, TRAC-OAC
Room: GIF, 360-C

Tuesday, 1030 - 1200

Information Operations in Force-on-Force Simulations
Timothy J. Bailey, CPT(P) Bobby Claflin, Roland Groover, TRADOC, ATRC-SAS

Brigade and Below Combat Information System
LTC and Asst. Prof. John A. Marin and LTC and Prof. James E. Armstrong, USMA

Advanced Field Artillery Tactical Data System (AFATDS) Milestone III Cost and Operational Effectiveness Analysis (COEA)
Ross A. Wells and Jimi D. Whitten, PhD, TRADOC, ATRC-SAA

VV&A Considerations in Research Using Battlefield Analysis Models
John Brand, Steven Kovel, and Hal Harrelson, ARL

Tuesday, 1530 - 1700

Battle Command Analyses in Prairie Warrior
Margaret A. Fratzel, TRADOC, ATRC-SAS

Analytic Support to Battle Command Advanced Warfighting Experimentation
Michael C. Ingram, TRADOC, ATRC-SAS

Using Process-Oriented Computer Simulation to Reengineer Traditional Stove-Piped Army Staffs for Information Operations in the 21st Century
MAJ Robert G. Phelan and LTC Michael L. McGinnis, USMA

Adaptive Architectures for Command and Control (A2C2)
Dr. Bill Kemple, Dr. Dave Kleinman, LT Neil Smith, NPS, and Dr. Elliot Entin, ALPHATECH

Wednesday, 0830 - 1000

A Workshop Report: Information Warfare (IW) & Deterrence
RADM James Cossey USN (Ret),SAIC and Dr. Richard E. Hayes, EBR

Unifying Planning and Analysis for Navy C3I
LCDR Kevin Schaaff, USN and Dr. Larry Wiener, Office of the CNO (N6C)

Analytical Modeling's Links to the Force XXI Command Post
CPT(P) Gregory A. Palka, TRAC-OAC

Integration of U-2 Capabilities into AFSOC Requirements
Paul G. Roberts and Thomas H. Plank Sverdrup Technology

Wednesday, 1330 - 1500

Mobile Integrated Non-Intrusive Command, Control, and Communications Instrumentation (MINI-C3I)
MAJ Lawrence L. Turner, Jr., John W. Diem, and Sherry A. Hannan, TEXCOM

The Anastomotic Reticulum (or Why Nothing is Simple)
W. Dean Spencer, SRC

Automated Evaluation of Tactical Radio Protocols
Maria C. Lopez, Ann E. Brodeen, George W. Hartwig, Jr., and Mike Markowski, ARL

An Adaptive Feedback Compensation Technique for Improving the Performance of Distributed Adaptive Routing Systems in Datagram Packet-Switched Communications Networks
Arthur S. Olsen, Army Material Systems Analysis Activity

Wednesday, 1515 - 1645
Assessing the Impact of Joint C3I on Joint Theater-Level Warfighting
LTC M. A. Youngren, D.P. Gaver, P.A. Jacobs, and S.H. Parry, NPS

Human-Centered C2 Modelling and Measurement for Army Battle Teams
Annette R. Ensing, MITRE, and Dr. Beverly G. Knapp, and Joyce Johnson, ARL

Tactical Communications in the Virtual Environment Lessons from the Focused Dispatch Exercise
James A. Calpin, MITRE

The Force Development Environment: Using Distributed Interactive, and Cooperative Simulations In A 21st Century Command and Control System
MAJ David L. Payne, MAJ Bill Branley, Bruce Dawson, Pete Grant, MAJ Earnest Harris, MAJ David Williams, Army AI Center

Thursday, 0830 - 1000
Exploratory Modeling and Information Operations
LTC Patrick Vye, TRADOC Research Associate, RAND

Air Attacks Against Fixed, Defended Ground Targets: Combat Models with Imperfect, Non-Instantaneous RSI/BDA
Christopher C. Reed, The Aerospace Corporation

Use of CASTFOREM in the Assessment of C3I Impacts at Brigade and Below
John K. Wilder, TRAC-WSMR

Thursday, 1330 - 1500
COMPOSITE GROUP IV SESSION .... GIF, Dupuy Auditorium

WG 15 — SPACE/C3I — Abstracts

Tuesday, 1030 - 1200
Information Operations in Force-on-Force Simulations

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As the Army seeks to design its forces to exploit the information age, it is developing doctrine and operational concepts based on information. The Army is evaluating various force designs and their ability to perform these information operations (IO) concepts through a series of tests, exercises, and Army warfighting experiments (AWE) which, in many cases, rely heavily on constructive simulations and war games to structure the exercise, drive the exercise, and/or extend the exercise through post-exercise modeling and analysis. In setting about to accomplish this task, Army analysis has found a need to ensure credible, accurate representations of informations operations in its force-on-force simulations and wargames.

This paper presents the IO representations needed for battalion/brigade and division/corps force-on-force simulations. The three major areas of IO (information systems, intelligence, and command and control (C2) warfare) are discussed and subdivided into the prime components that need to be represented in order to have a credible and accurate portrayal of information operations. A concept of modeling the information systems consistent with the Army Enterprise Strategy's operational architecture and system architecture is also presented.

Brigade and Below Combat Information System

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Abstract unavailable at printing.

Advanced Field Artillery Tactical Data System (AFATDS) Milestone III Cost and Operational Effectiveness Analysis (COEA)

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The TRADOC Analysis Center (TRAC) conducted the Advanced Field Artillery Tactical Data System (AFATDS) Milestone III Cost and Operational Effectiveness Analysis (COEA) to provide analytical support for the Milestone III Army System Acquisition Review Council (ASARC) decision review, 15 December 1995.

The methodology for this COEA included a cyclic use of three different levels of combat model. The artillery portions of the "big picture" obtained from the corps level model were used to add realism and drive the (higher resolution) artillery system level model. Output from this model was, in turn, used to drive the (higher resolution) communications level model. The communications level model simulated all artillery communications in minute detail and verified whether or not the communications systems were capable of passing the traffic assumed by the combat models. Where necessary, the high resolution output from the communications model was used to modify the input to the artillery system effectiveness model. The artillery system effectiveness model outputs, in turn, were used as input to the corps level combat effectiveness model.

This presentation will focus on study methodology and results. The COEA considered functionality, operational effectiveness, training and manpower implications, dependencies on other Army tactical command and control system (ATCCS) battlefield functional area control systems (BFACS), and cost. Final results were briefed to Headquarters Department of Army on 7 September 1995, and the final report was completed on 6 October 1995. The study assumed Army of Excellence force structure in the 1999 timeframe for Blue and 2004 for Red in two major regional contingency (MRC) scenarios. The study examined three alternative systems: Initial Fire Support Automation System (IFSAS), the base case, and two candidate AFATDS systems (V1 and V3). AFATDS V3 provided the greatest effectiveness.

VV&A Considerations in research Using Battlefield Analysis Models

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<u>Tuesday, 1530 - 1700</u>
Battle Command Analyses in Prairie Warrior

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This paper discusses the evolution of Force XXI battle command analyses associated with the Prairie Warrior exercise conducted by the Command and General Staff College at Ft. Leavenworth, KS. Battle command analyses have been conducted in each of the annual student exercises since 1993. With the designation of Prairie Warrior as an Army Advanced Warfighting Experiment (AWE) in 1995 and 1996, the emphasis on analysis of battle command issues in this exercise has increased.

The paper discusses the context of the exercise and associated preparatory events, and identifies critical assumptions and limitations of the analyses within this context. This includes a discussion of the unique use of the Mobile Strike Force, and in 1996, the representation of the Army's Experimental Force (EXFOR) at Ft. Hood, TX, in the exercise. The types of issues are highlighted, along with a sampling of the approaches used to address various issues. With regard to battle command, the issues span the domains of doctrine, training, leader development, organization, material, and soldiers. Selected results are presented, and factors associated with increasing the fidelity of the analyses are discussed. Potential future applications are also identified.

Analytic Support to Battle Command Advanced Warfighting Experimentation

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This paper briefly describes the primary efforts of the U.S. Army Training and Doctrine Command (TRADOC) Analysis Center (TRAC) to support the U.S. Army Battle Command Battle Laboratory (BCBL) Advanced Warfighting Experiments (AWE) in 1994, 1995, and 1996. Analytic support efforts in this environment have relied upon a set of tools other than the usual modeling and simulation, although simulation exercises (SIMEXs) are the main experimentation events. During each of these years, the BCBL used students in an elective class of the Fort Leavenworth's Command and General Staff officer Course's (CGSOC) Battle Command Elective (BCE) as the vehicle for experimentation. This elective grew in three years from 28 to 73 to 89 participants. Each year, this class formed the core of the command and staff of the Mobile Strike Force (MSF), a notional experimental unit for Force XXI development. Each year, the BCE culminated its effort by fighting, augmented with additional CGSOC students, as the MSF in the CGSOC Prairie Warrior (PW) Exercise.

The approach taken to analytically support the BCBL evolved to one in which the TRAC study team totally integrated with the BCE in 1995 and 1996. The team attended all BCE classes, seminars, guest speaker sessions, tactics, techniques, and procedures (TTP) development sessions, SIMEXs, and after action reviews. This enabled accomplishment of comprehensive data collection plans which always include literature review, review of prior AWE results, observation of all BCE activities, and administration of student surveys. The surveys are the tool upon which many of the key insights from the AWEs are either initially developed or further explored. This paper will focus on how statistical analysis of student surveys, and observations of BCE activities were combined to address Force XXI battle command issues.

Using Process-Oriented Computer Simulation to Reengineer Traditional Stove-Piped Army Staffs for Information Operations in the 21st Century

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Recently, the US Army has been confronted by a wider range of military and peacekeeping operations. The future success of the Army on tomorrow's battlefields depends, in part, on how effectively our forces are able to fight and win the information war. We present a computer simulation approach being developed for the Army Digitization Office (ADO) for reengineering the current stove-piped organization of tactical Army staffs into staffs organized for information operations in the 21st century. This approach will assist the ADO in evaluating staff alternatives.

Adaptive Architectures for Command and Control (A2C2)

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A2C2 is an ONR-sponsored project to: extend 12 years of Navy decision-making research into the joint C2 arena; expand beyond the anti-air warfare arena; focus on adaptive architectures; and produce results ranging from purely theoretical to those useful to the operational forces in the near term. This "industry-university-government" initiative approaches the problem through field, experimental, and theoretical research. Included are: interviews with joint officers; participation in exercises and demonstrations; pooling of theoretical and analytical techniques to provide models of decisions; replicated experiments with officers in war games; measurement of individual and team performance; and formulation of training, software, or hardware improvements.

This talk describes the first experiment which was designed as an integration vehicle to: adapt an existing game simulator (DDD) to the broader operational domain; examine C2 structure as an independent variable; identify current research issues common to the operational and theoretical domains that can be examined within the context of the interview scenario; develop the scenario and tasks to a level amenable to modelling analytically and in simulation; and examining measures that may be useful for research into adaptable C2 architectures.

The specific research issue is: "can tasks differ in coordination requirements in such a way that a structure with more layers is better for some tasks, and a structure with fewer layers if better for the others?" The scenario was adapted from the scenario used for the joint officer interviews.

Wednesday, 0830 - 1000

A Workshop Report: Information Warfare (IW) & Deterrence

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Unifying Planning and Analysis for Navy C3I

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Navy C3I stands out as an area which unhappily has eluded the development of a unified, coherent, and generally accepted family of supporting analytic methodologies. These methods would be used commonly for operational planning, program development, system development, budget submissions, and a host of other application areas. There is a number of reasons for this inability to settle on a family of methodologies. One of the major ones has been the inability of analysts and operators to relate technical parameters to operational performance factors. One reason for this has been a nagging feeling among many participants that a strictly quantitative argument is essentially unachievable, that in fact C3I analyses require the early and continuing integration of non-quantifiable operational insights.

In an effort to develop a unified framework for Navy C3I analysis we have leveraged two developing and interrelated technologies and integrated them within the classical techniques of seminar war gaming. The two technologies are high speed computation and display, and object-oriented simulation environments. Our methodology involves using these technologies to develop candidate C3I architectures and to compute measures of how well they support tactical operations. Both the architectures and measures of effectiveness can be changed Ron-the-flyS during war gaming sessions, and new results can be developed in minimum computing time. In this way, the participants can identify C3I configurations and operational concepts which both meet requirements for necessary operational support and also achieve high levels of technical performance. This paper describes how we successfully applied the methodology to Navy program planning to support sensor-to-shooter operations.

Analytical Modeling's Links to the Force XXI Command Post

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This paper will illustrate the need for the analytical modeling community to expand the interaction with the CINCs, subordinate commanders and staffs in analyzing the actual contingency and operations plans for the specific theater or operation. The first version of the Army Tactical Command and Control System (ATCCS) will be fielded in the next five years. These devices will be the primary tools the commander and staff will use in correlating, filtering, processing, extracting, and formatting information for the force.

The focus of this paper is the ATCCS, specifically the Maneuver Control Station's ability to automate the wargaming and course of action analysis process during the commander and staff's conduct of the Command Estimate Process and how this new *automated* wargaming relates to current Corps, Division and Brigade analytical modeling being conducted by Army modeling agencies. With the advent of automated wargaming (i.e. analytical modeling) in the future command post, one group of future military analysts is the young officers and non-commissioned officers serving in staff and command positions in brigade and higher command posts. These *future military analysts* have little knowledge and no training in the conduct of automated wargaming and the implications it has on the decision making process. The modeling community should begin now to inform, and instruct the future analysts and commanders on the use of automated wargaming results by modeling the current *real world* contingency and operations plans. The Army Modeling Community should greatly expand the analytical modeling work with the CINCs, and subordinate commanders and staffs to ensure we effectively train and grow the next generation of military analysts and decision makers in the effective use of analytical modeling results. This exposure will have the following advantages. First, when the new wargaming technologies are fielded on the battlefield, leaders will be ready to exploit the capabilities effectively and recognize the weaknesses. Second, the modeling community and commanders will have a set of base scenarios to compare and contrast the results produced by the ATCCS systems. Finally, the Army can begin the examination and probable revision of the tactics, techniques and procedures commanders and staffs use to implement the Command Estimate Process and the possible results they will have on the outcome of battle.

Integration of U-2 Capabilities into AFSOC Requirements

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There is an urgent and growing need to leverage technologies and capabilities in revolutionary ways to provide in-time intelligence support at all levels, including the individual warfighter. The paper explores feasible options for exploiting U-2 Reconnaissance System capabilities, beyond their traditional role, to provide solutions to Air Force Special Operations Command (AFSOC) operational intelligence deficiencies identified in formal requirements documents. The paper discusses how the combined elements of aircraft performance characteristics, sensor capabilities, data links, and ground processing stations make the U-2 a unique system to support the critical needs of special operation forces (SOF) for near-real-time intelligence.

A representative scenario is included that illustrates specific examples where U-2 capabilities could provide in-time intelligence during the mission planning, rehearsal, and execution timelines. With the U-2 likely to already be operating where SOF are employed and the connectivity between the U-2 CARS ground station and AFSOC intelligence support systems already existing within the current C4I architecture, the paper concludes that U-2 capabilities can be effectively integrated in support AFSOC requirements. However, an increased understanding of each other's capabilities and mission requirements within the U-2 and SOF communities is needed to realize the full potential of integration.

Wednesday, 1330 - 1500

Mobile Integrated Non-Intrusive Command, Control, and Communications Instrumentation (MINI-C3I)

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Force XXI implements the concepts of power projection and information warfare to mobilize, employ, and sustain highly trained combat forces anywhere in the world. This will involve upgrading weapon and communication systems to use the capabilities of emerging digital technology. This digitization of the battlefield will significantly change the command and control architecture of the new digitized force. The resultant command and control infrastructure will need to be tested to ensure it provides the commanders the right information at the right time. MINI-C3I is being developed to enable this new architecture to be tested and evaluated. MINI-C3I will provide the capability of collecting internal and external data from mobile or static units composed of varying numbers of combat, combat support, and combat service support units. Data collection instrumentation and statistical analysis software will be developed to a level that will support evaluation of the implementation of battlefield digitization initiatives from the weapons platform to Corps level. These data can then be used to evaluate the horizontal (interoperability) and vertical command and control functionality. To conduct cost effective testing, the system will be integrated with the Family of Simulations (FAMSIM) (e.g., Corps Battle Simulation (CBS) with attendant interfaces, JANUS, Brigade and Battalion Simulation (BBS), Extended Air Defense Simulator (EADSIM), etc.) to provide the required levels of detail and battlefield information flow to properly stimulate player units, commanders, and staffs during operational tests and experiments.

The Anastomatic Reticulum (or Why Nothing is Simple)

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In reducing a problem to a scope amenable to analysis or simulation, we typically "cut away" the non-relevant features and then map what is left homomorphically into the largest equivalence or quotient classes possible. Taken to the extreme, we intuit an axiomatic system capable of expressing (at least) the essentials left from the cutting. Thus we hope to define meaningful structures without reality, probability without events, and systems without components.

Stafford Beer, past President of the Operational Research Society, London used a simple example to show an 8 bit register is needed to characterize a two binary input/two binary output system and that a 10^{92} bit register is required to characterize a 300 binary input/300 binary output system..

Extending his analysis to a realistic problem in which there is a wide range of input/outputs with continua of values, we rapidly discover that we are faced with not an incomprehensible number such as 10^{92} bits, but with a genuine inability to even determine the variety of the system under consideration.

Whereas, at times we create a matrix of elements which may bear morphological relationships to one another, under real but not unusual conditions we would require a "matrix" of arbitrarily large dimension and indeed, a continuum of values throughout. In fact the reticulia of inputs are so dense, they have no stoma, i.e., they are anastomatic reticulia (or reticules).

But -- these systems work: they "take-place." The difficulty lies in our attempts to properly reduce them to manageable proportions. We require an ability to create the genetic structure (axioms), initial and boundary conditions (probability distributions) and variety generators (system architecture).

This presentation puts forth several illustrative examples of "how simple things are not simple" and possible methods of "making them simple" by use of variety reduction, matching requisite variety, and variety generation.

Note: The concepts underlying this paper were developed by Stafford Beer, formerly President of the Operational Research Society, London; Vice President and Governor of the Society for General Systems Research, Washington; and founder of the International Association for Cybernetics; who was awarded the Lanchester Prize in 1966 from the Operations Research Society of America, and a Resolution of Thanks from the United States House of Representatives; a significant portion of his work rested upon the insights provided by Ross Ashby (variety), Weiner (Cybernetics), McCulloch and Pitts (neural nets), and Von Neumann (majority voting). His developments in OR and Cybernetics implicitly foresaw the decline and demise of AI (as expressed in "Expert Systems"), "Fuzzy Logic", and today's neural networks (not including Carver Mead's use of analog VLSI).

I am not aware of anyone who has utilized these ideas which were and remain ahead of their time. Dr. Myron Tribus' lucid approach in Rational Descriptions Decisions and Designs, Pergamon 1969 based on seminal work of Jaynes and Cox complements Beer's work. Dr. Frank Greco, President of Greco Research, Phone (804) 456-9602, Virginia Beach, Virginia, has the background to address these concepts.

Beer wrote among other books) the following: Decision and Control, Wiley 1966; Brain of the Firm, Herder & Herder, 1972; Platform for Change, Wiley 1975. It's time to revisit and promulgate Beer's profound insights into Cybernetics and Operations Research.

Automated Evaluation of Tactical Radio Protocols

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Decentralized battlefield command and control requires reliable and timely distribution of information. At present, distribution of digital information is limited by noisy channels inherent to combat net radios and heavy traffic demands, forcing commanders to make decisions from less than optimal information. In the ideal communications network each node would be smart enough to monitor network performance and, when necessary, adapt itself to better accommodate its workload. The adaptive network node would employ a decision algorithm to modify configuration, routing and protocol parameters based on measured network performance and system requirements. Our research addresses control of noise and interference on communication channels and construction of network protocols that will be effective on the modern battlefield. The approach emphasizes use of actual hardware and controlled experimentation to explore alternative protocols. This paper describes a suite of software to automatically collect and evaluate baseline performance data for a prototype communications network and to determine those factors to which the system is most sensitive.

An Adaptive Feedback Compensation Technique for Improving the Performance of Distributed Adaptive Routing Systems in Datagram Packet-Switched Communications Networks

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The Tactical Internet utilizes tactical radio systems with low transmission capacities. Efficiently operating data networks at high utilizations requires more sophisticated routing systems than currently available. Routing improvements are a cost-effective means to increase performance by better utilizing existing transmission resources.

Contemporary distributed adaptive routing systems for datagram packet-switched networks exhibit poor stabilization and convergence properties at moderate offered loads without the addition of experimentally determined Bertsekas Additive Bias Factors. Bertsekas has shown that routing systems are confronted by more than the shortest path problem; they must also deal with feedback effects, as cost estimates used to select routes are themselves affected by the route selection. Unfortunately, while use of Bertsekas Additive Bias Factors improves system stability, it also reduces the sensitivity of the routing system to network congestion. This analysis was motivated by a search for adaptive

feedback compensation techniques which improve routing system stability without introducing a loss of congestion sensitivity and which self-optimize for current network conditions.

A distributed collaborative update policy was developed which places constraints on the number of allowed routing state changes so as to tune adaptive jumps to the correlation length of the performance surface, the Kauffman Criteria for optimal adaptation. Through simulation, it is demonstrated that the improved routing system avoids the Kauffman Complexity and Eigen Error Catastrophes observed in underbiased and overbiased routing systems, respectively. Above moderate offered loads, up to a 20% increase in throughput and a four-fold reduction in average packet delay is observed with the update policy enhancement.

Wednesday, 1515 - 1645

Assessing the Impact of C3I on Joint Theater-Level Warfighting

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Naval Postgraduate School
Operations Research Department
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Monterey, CA 93943

A major weakness of legacy simulation models within the department of Defense is their attrition focus: as a result, non-lethal systems have little or no effect on projected warfighting outcomes. This fact has made the analysis of the impact of C3I systems on the warfight difficult. The Naval Postgraduate School, as part of the Joint Stochastic Warfare Analysis Research (J-STOCHWAR) program, has developed methodology to represent operational intelligence and command and control processes, using stochastic representations to explicitly treat uncertainty and decisionmaking under uncertainty.

J-STOCHWAR has focused on developing models simulating the collection, processing, and fusion of intelligence at the operational level; representing the perception that can be developed (with quantifiable uncertainty) at the operational level, both of the current battlespace and of enemy intent; and showing the effect of various strategies to develop or confound that perception. This approach enables analysts to model variations in C3I processes and show their impact in terms of Measures of Force Effectiveness (MOFEs). The models are intended to be useful for a range of joint warfare analysis, and can be incorporated into specific theater-level simulation models if desired. NPS has also developed an experimental prototype simulation to demonstrate and evaluate the models developed in research. This software (the Joint Warfare Analysis Experimental Prototype, or JWAEP) can be used in either a wargaming mode or a closed analysis mode to explore various alternatives in joint C3I supported by the models developed to date. This presentation will present results developed over the past year and provide an overview of ongoing and future research.

Human-Centered C2 Modelling and Measurement for Army Battle Teams

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The next generation of C2 (Command and Control) concepts, C2 vehicles, and advances in computer and communication technology provide the Army with the elements to significantly enhance C2 Team performance on the battlefield, while potentially decreasing personnel. Finding the right tactics, organization, soldier-machine interface, personnel, and training needed to maximize the utility of the next generation C2 environment is a major challenge. Modelling and measuring C2 accurately has been a difficult problem, because: conventional task analysis methods are not well suited for the complex, continuous, non-sequential, primarily cognitive tasks characteristic of C2; and, most models deal with C2 communications and omit human processing.

This paper describes a method for modelling and evaluating C2 tasks and workload, to optimize manpower allocation and systems designs, using human process-oriented data collections and syntheses to determine how information flows through the C2 system, and how it impacts the tasks performed. Information ÒeventsÓ are the incoming transformed data which trigger detailed task processes performed by the operators. Techniques were developed for decomposing decision tasks for both individuals and groups. An existing networking and resource allocation analysis tool was adapted to model and measure mental task demands and timelines. An analysis framework, developed to both isolate and combine the many C2 variables of interest, permitted a variety of Òwhat ifÓ excursions (e.g., noise, communication delays, new software, distributed operations). Although developed for Army C2 at a tactical level, the method appears robust and applicable for any C2 center.

Tactical Communications in the Virtual Environment Lessons from the Focused Dispatch Exercise

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Abstract unavailable at printing.

The Force Development Environment: Using Distributed, Interactive, and Cooperative Simulations In A 21st Century Command and Control System.

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The US Army Artificial Intelligence Center has begun to develop a concept for an advanced, next-generation, Command and Control System into a working prototype that combines a highly graphical user interface with a novel human-computer interaction paradigm and a sophisticated set of model servers. The result is a system of systems approach to supporting the war planner and force developer with an automated environment that focuses human input on tactical and operational decision making while off-loading administrativeand support tasks to remote models and man-machine work groups. The architecture consists of the interface, a team of

expert agents observing and reacting to human interventions at the interface, a model-server that connects the interface expert agents with resource server agents, and the underlying network of remote models and supporting C4I systems. The interface and both types of agents will rely heavily on Distributed Interactive Simulation (DIS) concepts, as well as on emerging advanced concepts, to provide operation planners and analysts a powerful visual programming environment with automated access to detailed supporting models.

Thursday, 0830 - 1000

Exploratory Modeling and Information Operations

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Abstract unavailable at printing.

Air Attacks Against Fixed, Defended Ground Targets: Combat Models with Imperfect, Non-Instantaneous ISR/BDA

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The purpose of these models is to explore interactions among (a) Weapon systems, (b) Intelligence, Surveillance, and Reconnaissance (ISR) capacity, accuracy, and timeliness, (c) Concepts of Operation, and (d) Scenarios. These interactions allow us to estimate the sensitivity of top-level Measures of Effectiveness (MOEs such as BLUE losses and time taken to achieve BLUE s operational objective) to factors such as - Improved weapons Pk at longer range (due to technology advances), - Improved ISR/Battle Damage Assessment (BDA) capacity, accuracy, and timeliness, - RED ISR/BDA deception tactics, - Improved ISR/BDA counter-deception capabilities, - Alternative concepts of operation (as defined by parameters such as number of targets attacked per wave, attacker weapon mix, etc.), - Changes in scenario parameters (e.g., total numbers of targets and non-targets).

The effects of imperfect, non-instantaneous ISR/BDA on combat attrition are captured by a set of target states which allow the model to keep track of whether a target was attacked during the current attack wave, whether it survived, whether or not ISR/BDA has updated a target, whether it has correctly identified a target, and whether it has correctly assessed battle damage to attacked targets. Target state populations after the (n+1)st wave are computed from target state populations after the nth wave via functional dependencies involving the attrition, ISR/BDA, ops concept, and scenario models used. By tracking these target state populations with time, it is possible to unravel the chains of cause-and-effect that lead to the (sometimes counterintuitive) sensitivities of MOEs to the various parameters mentioned earlier.

Use of CASTFOREM in the assessment of C3I impacts at Brigade and below.

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Approved abstract not available at printing.

Thursday, 1330 - 1500

COMPOSITE GROUP IV SESSION
GIF, Dupuy Auditorium

WG 16 — MILITARY ENVIRONMENTAL FACTORS — Agenda

***Chair:* Eleanor Schroeder, Ocean Executive Agent Office**
***Cochair:* Warren Olson, Institute for Defense Analysis**
***Cochair:* Tom Piwowar, Science and Technology Corp.**
***Advisor:* Stan Grigsby, Consultant**
Room: GIF, 254-D

Tuesday, 1030-1200: Environmental Effects

Environmental Effects for Distributed Interactive Simulations: Final Products and Lessons Learned
Stan Grigsby, Consultant

Environmental Effects for Naval Warfare Simulations
Peter Chu, Naval Postgraduate School

Analysis of the Impact of Terrain Resolution on M&S Outcomes
C. D. Bullock, USAE Waterways Experiment Station

Tuesday, 1530-1700: Meteorology

Support of Environmental Requirements for Cloud Analysis and Archive: Multiple-Satellite Global Cloud Modeling for DoD Applications
Frank Kelly, Atmospheric and Environmental Research, Inc.

Real-time Short-term Cloud Forecasting: Applications to Realistic Military Modeling
Frank Kelly, Atmospheric and Environmental Research, Inc.

The Battle Weather Test Bed: Leveraging Technology for Army Weather Support Through The Integrated Meteorological System
John Elrick, U.S. Army Research Laboratory

Wednesday, 0830-1000: Algorithms

A Tabu Search Based Heuristic for Site Selection Considering Ground Mobility
Jeff Williamson, USAE Waterways Experiment Station

Obstacle Planner Software
Philip L. Doiron, USAE Waterways Experiment Station

IPB Process Value-Added Via Computer-Aided Procedures: Emerging Results
Dr. Niki C. Deliman, USAE Waterways Experiment Station

Wednesday,1330-1500: Mobility Models

Predicting Mission-Related Terrain-Induced Energy Levels in Current Military Vehicles
John G. Green, USAE Waterways Experiment Station

Modeling the Influence of Driver Fatigue on Vehicle Performance
Jeffrey L. Williamson, USAE Waterways Experiment Station

Ground Vehicle Simulation: A Standard Model for the 3 Modeling Environments
Dr. William Willoughby, USAE Waterways Experiment Station

Wednesday, 1515 - 1645 Technical Exchange

Thursday, 0830-1000: Technical Exchange

Thursday,1330-1500

COMPOSITE GROUP IV SESSION .... GIF, Dupuy Auditorium

Tuesday, 1030-1200

Environmental Effects for Distributed Interactive Simulations: Final Products and Lessons Learned

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Approved abstract not available at printing.

Environmental Effects on Naval Warfare Simulations

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The Environmental Effects on Naval Warfare Simulations (E2NWS) project seeks to better incorporate environmental effects into simulations of naval warfare in the littoral.

The two major components of E2NWS are war games and numerical models of the littoral environment. The Wargaming Laboratory of the Naval Postgraduate School (NPS) provides the Research, Evaluation, and Systems Analysis (RESA) facility and the Joint Theater Level Simulation (JTLS) system. Environmental factors of interest include tides, waves, currents, and weather. The NPS Naval Ocean Analysis and Prediction (NOAP) Laboratory will leverage the numerical ocean models operational at the Naval Oceanographic Office (NAVOCEANO) and the civil works expertise of the U. S. Army Engineer Waterways Experiment Station, Coastal Engineering Research Center (CERC) to describe the littoral environment. The Mississippi State University Center for Air/Sea Technology (CAST) will provide expertise in statistical simulations, data analysis and management, and visualization.

Three phases are planned during the initial two years of the E2NWS. Phase one will implement the war games and environmental models, if necessary, and build the data access procedures. The second phase will test the sensitivity of these war games to environmental factors. The final phase will couple the war games with operational environmental models.

This project will assess the influence of the littoral environment on naval warfare. The results will be relevant to continued Navy support of environmental depiction and prediction as well as highlight the need to consider environmental effects in estimates of warfare effectiveness.

This paper presents the goals of E2NWS, the structure of the project, and early results.

Analysis of the Impact of Terrain Resolution on Modeling and Simulation (M&S) Outcomes

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A high level of terrain correlation is required for simulations participating in a Distributed Interactive Simulation (DIS) environment to achieve consistent outcomes among the simulations, convey realism and impart credibility to the results. With respect to virtual simulations, each computer image generator (CIG) is constrained by the computational power available to depict images. Constructive models typically use raster format for elevations and features; although, models in the Janus lineage are using polygons to represent features. Line-of-sight (LOS) calculations are demanding consumers of processing capabilities in constructive simulations. As terrain resolution increases, LOS calculations, generally, increase as well. With these varying terrain representations and hardware restrictions, the question remains regarding the level of terrain resolution required for agreement in a DIS environment between live and the M&S domain. From an interoperability viewpoint each participant must "see" and "interact" within the same terrain environment to ensure a "level playing field".

If technology and cost were not limiting factors, one might say that ground truth is the requirement for M&S. However, resources are indeed limited; consequently, prior to answering the terrain data resolution and correlation issues, the impacts, constraints, trade-offs, and associated costs of using varying terrain resolution in simulations, stand-alone and the DIS environment, must be thoroughly examined and analyzed. This paper discusses a quantitative and qualitative analysis of existing information relating to the impact of terrain resolution on M&S outcomes with respect to line-of-sight, battle outcomes, processing and preprocessing time.

Tuesday, 1530-1700

Support of Environmental Requirements for Cloud Analysis and Archive (SERCAA): Multiple-Satellite Global Cloud Modeling for DoD Applications

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Determination of cloud presence, properties and radiative influence are high priority requirements for defense related operations. An ongoing program to address DoD needs is the Support of Environmental Requirements for Cloud Analysis and Archive (SERCAA). This program is a two-phase basic research effort to develop techniques for analysis of multi-source, multi-spectral satellite sensor data for the purpose of estimating cloud fractional amount, location, height, and type. Data sources for thiswork include both NOAA and DoD polar-orbiting meteorological satellites and NOAA geostationary meteorological satellites. In the now completed first phase, separate cloud analysis algorithms were developed for each imaging sensor in order to best exploit the information content unique to the individual data sources. A major innovation was the development of an analysis integration approach based on numerical weather prediction data assimilation techniques to combine sepearate algorithm results from the temporally, spatially, and spectrally inconsistent sources into a single logically consistent analysis. Work in the second phase expands to include algorithms for retrieval and estimation of cloud physical and optical properties such as phase, drop size distribution, optical thickness, and emissivity. Other parameters of interest are vertical profiles of temperature and moisture, surface temperature, and cloud liquid water content. Applications of the research efforts are underway

to implement the SERCAA algorithms at central weather processing facilities. Other applications of the algorithms include incorporation in the areas of enhancing determination of environmental information into battlefield intelligence systems.

Real-time Short-term Cloud Forecasing: Applications to Realistic Military Modeling

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Cloud forecasting is recognized as one of the most difficult problems in weather forecasting. Lesson learned from Desert Shield/Desert Storm and recent experience in Bosnia attest to the impact of clouds and their forecasts on military missions. As simulation and modeling of military missions continues to evolve, the importance of realistic cloud forecasts is increased. Current site specific techniques are usually subjective with little validity for larger regions. Additionally, trajectory-based forecasts using wind fields generated from numerical prediction models suffer inaccuracies due to cloud height assignment and suboptimal use of actual local cloud motion observations. Responding to a need for realistic and reliable short-term forecasts of cloud cover, AER's correlation extrapolation forecasting - AER Cloud Eye (ACE) - addresses the difficulty of cloud forecasting by making direct use of actual cloud displacement observations. The method is fast; producing 2-3 hour forecasts for large areas in several minutes and requires no 'spin-up' time, as expected in other model-based techniques. The method uses imagery from geosynchronous meteorological satellites and takes advantage of multi-spectral sensor data. Applications to mission modeling and simulation are discussed and future applications suggested.

The Battle Weather Test Bed: Leveraging Technology for Army Weather Support Through the Integrated Meteorological System

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The Integrated Meteorological System (METS) is a state-of-the-art "soldier support" system to provide advanced meteorological technology and accurate weather-related information to Air Force Weather (AFW) personnel in worldwide Army operations. The IMETS is evolving through a block-improvement fielding approach implemented by the Project Director, IMETS through the Army's Program Executive Office Command, Control, and Communications Systems. The Battle Weather Division of the Battlefield Environment Directorate develops computer-based technology throught the Battle Weather Test Bed (BWT). The results of the BWT research and development activities are used by AFW forecasters to inform battlefield decision makers of weather conditions that will affect operations and facilitate prudent employment choices. BWT technology enables AFW personnel to provide more accurate weather support and allows the operational Army to use the knowledge of weather effects as a force multiplier.

Wednesday, 0803-1000

A Tabu Search Based Heuristic for Site Selection Considering Ground Mobility

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Support Elements on the battlefield must be able to respond quickly and effectively to the demands of other elements on the battlefield. The sites on which these support elements are stationed must be strategically selected to allow support elements, such as supply elements, to reach the demand points within a specified time frame. The time required to provide this support is crucial and must be minimized.

Military vehicles move on-road and off-road in sometimes challenging conditions. With the introduction of off-road travel, the military site selection problem becomes far more complex than similar civilian site selection problems, such as locating emergency medical services and commercial distribution centers.

The major effort of this research was devoted to developing a methodology that would maximize coverage within an area of operations and minimize the number of facilities needed to provide the coverage within a specified time frame.

The methodology developed incorporates a modification of the tabu search procedures and utilizes the time contour analysis algorithms developed by the Waterways Experiment Station. A computer based tactical decision aid incorporating this methodology was developed within the Comprehensive Army Mobility Model System - Developmental (CAMMS-D) which meets the geographic information system (GIS), user interface, and graphics requirements for demonstration.

The purpose of this presentation is to describe the problem formulation and solution methodology.

Obstacle Planner Software

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The Obstacle Planner Software (OPS) is an ongoing research and development program within the Corps of Engineers focused on automating the combat engineer's role in the decision process. This includes providing decision support tools that directly support the engineers in mission analysis, course-of-action development, and course-of-action analysis. OPS builds on past and present research and development efforts in engineer mobility and countermobility. The typical results of this research are physics-based models that require very descriptive inputs and provide a level of detail necessary for engineers to plan and execute their missions. The synergism between existing artificial intelligence technologies and the physics-based engineering models supports the creation of decision algorithms that allows engineers to provide realistic assessments of engineer operations to the commander to meet the requirements of FORCE XXI.

Since the program started, OPS has continually increased its capability of automating the engineer's decision process. OPS' recent participation in Prairie Warrior 95 (PW95) allowed the engineers, for the first time, to digitally plan and transmit engineer

related information horizontally and vertically among the echelons. One contributing factor in the success of OPS during PW95 was its ability to manage tremendous quantities of Defense Mapping Agency feature data and use these data in performing detailed analysis for use by the decision makers. During FY95 the capabilities were expanded by the addition of a relational database (used in modeling the situational awareness) and a rule-based expert system (used to model human expertise or knowledge).

IPB Process Value-Added via Computer-Aided Procedures: Emerging Results

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Intelligence Preparation of the Battlefield (IPB) functions related to mobility at brigade are typically time sensitive, time consuming procedures performed manually. The S-2 largely depends on materials at hand to support the commander. The interpretation of available materials, including maps, per se is subjective and does not incorporate many factors affecting ground mobility. Computerized procedures that incorporate multiple factors in evaluating ground vehicle mobility exist but are not readily available at echelons brigade and below. These methodologies potentially offer increased quality, consistency, objectivity, and completeness in products and analyses as well as time savings for the analyst.

It is important to evaluate the value added by incorporating such automated procedures into interactive, geo-referenced systems that can be utilized in the IPB process at echelons brigade and below. In support of this objective, a study is being conducted to identify mobility-related IPB functions that can be automated to improve the IPB process. This study involves comparing manual and computer-aided IPB procedures using designed experiments to measure value added. Surveys are being used to elicit information concerning perceived benefits derived from the computer-aided approach. The purpose of this paper is to present emerging results gathered from experiments conducted with the Military Intelligence Officer Advanced Course in Fort Huachuca, Arizona.

<u>*Wednesday, 1330-1500*</u>

Predicting Mission-Related Terrain-Induced Energy Levels in Current Military Vehicles

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The mobility performance of a vehicle is a complex function of the vehicle characteristics, the terrain in which it is operating, and the mission it is required to perform. Mobility models such as the NATO Reference Mobility Model (NRMM) give a good indication of how well a vehicle can perform speed-wise over certain terrain given a specific mission (e.g., tactical high, tactical standard, tactical support, or on-road) where pre-determined percentages of primary roads, secondary roads, trails, and off-road terrain are used in order to complete the mission. However, the measure of energy absorbed by a vehicle given a mission over specified terrain is often overlooked. Presented is a methodology to predict the mission-related terrain-induced energy level incurred by a vehicle. This methodology entails using the Dynamic Analysis and Design System (DADS) in the initial stages to create the necessary speed, surface roughness, and absorbed power relationships. NRMM is then used to make terrain unit speed predictions from which mission rating energy levels can be computed. An application of this procedure would be to evaluate suspension systems for military vehicles.

Modeling the Influence of Driver Fatigue on Vehicle Performance

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While similar ground vehicles possess basically the same performance potential under similar conditions, the final performance of the vehicle is greatly affected by driver influence. Many complex human factors such as driver fatigue affect both the mental and physical condition of the driver; in turn, the performance of the vehicle is also affected.

The current edition of the NATO Reference Mobility Model (NRMM II) does not consider the influence of driver fatigue on vehicle performance. The research discussed herein was conducted to compensate for this deficiency.

The methodology developed was based on a relationship which described the natural inclination of a driver to decelerate over contiguous driving times. This relationship indicated an increase in probability that the driver would decelerate as time progressed. By incorporating this probablistic relationship with classical decision theory techniques and advances made during the WES's stochastic mobility modeling research, an algorithm was developed to adjust the NRMM II's speed predictions according to the length of time the driver has continuously operated the vehicle.

The Comprehensive Army Mobility Model System - Development (CAMMS-D), which was developed by personnel at WES, served as a testbed for evaluating the resulting tactical decision aid incorporating this methodology. CAMMS-D provided the georgraphic information system (GIS), the user interface, and the graphical display capabilities necessary for such an evaluation.

Ground Vehicle Simulation: A Standard Model for the 3 Modeling Environments

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Futuristic, highly agile, and lightweight vehicles with new power-trains (e.g., electric drive, modular unit, robotics) and improved suspensions (e.g., active daming, hydropneumatic) will require more responsive algorithms to accurately predict vehicle mobility. Prototyping in a virtual environment would permit evaluating design changes to concept vehicles without expending tax-payers' dollars on building prototype vehicles. The inclusion of a standards-based, high-fidelity ground vehicle simulation module will greatly increase the accuracy of vehicle prototyping. Moreover, the same module could be implemented into training simulators to insure realistic representation of vehicle mobility on ground vehicle training. Non-standard representations lead to inconsistent results, expecially across Distributed Interactive Simulations (DIS).

The objective of this research thrust is to develop a high fidelity ground vehicle mobility module (GVSM) for inclusion in the Comprehensive Army Mobility Model-Developmental and other models in the live, virtual, and constructive modeling environments. The GVSM will permit the accurate and realistic representation of vehicle trafficability and dynamics over hard and soft soils, crossing wet (fording/swimming) and dry gaps, human factor effects on vehicle performance (i.e. fatigue, driver skill levels, etc.), and the vehicles effects on the environment (i.e. dust, rutting, etc.).

WG 17 — OPERATIONAL CONTRIBUTION OF SPACE SYSTEMS —Agenda

Chair: Gary Streets, SWC/AEW
Cochairs: Lt Col Frank Swehosky, AFOTEC/SA
LTC Jack Marin, USMA
Paul Szymanski, Aegis Research Corp
Room: GIF, 354-D

Tuesday, 1030-1200
The Cost of Doing War
Oliver Cathey, Sparta Inc and 1Lt Shawn Baerlocher, SMC/XRER

Space Impact Assessment Methodology (SIAM) Study
Paul Szymanski, Aegis Research Corp

Tuesday, 1530-1700
Air Force Space Command's New Vector
Lt Col Thomas Wiederrecht, HQ AFSPC/XPA

Air Campaign Utility Analysis of GPS Guided Munitions
Capt David Lucia, SWC/AEW

Space Play in Theater Level Models
Capt Robert Payne, AFIT/ENS

Wednesday, 0830-1000
Military Utility-Based Space Force Mix Optimization Using Analytical Hierarchy Process
Maj David Taylor, SWC/AEW

Non-Linear Dynamic Military Utility Analysis Technique
Capt David Lucia, SWC/AEW

Wednesday, 1330-1500
Intercontinental Ballistic Missiles as Space Launch Vehicles
Capt Jeffrey Grobman, Office of Aerospace Studies (AFMC)

Cost Effectiveness of Innovative Upper Stage Propulsion and Electrical Power Technologies
Christopher Feuchter, Office of Aerospace Studies (AFMC)

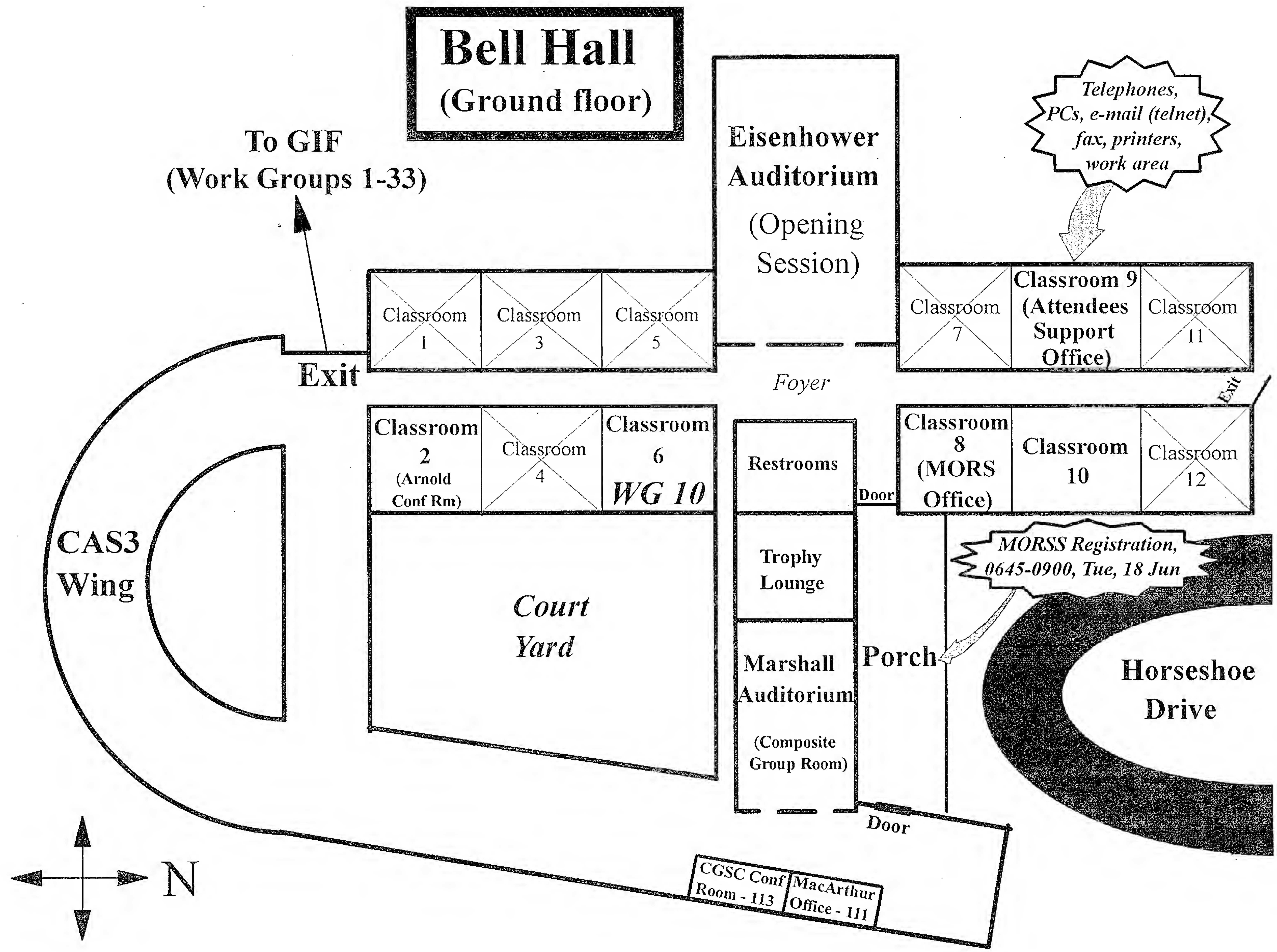
Wednesday, 1515 - 1645
A Complete System for the Extraction of Roads from Multispectral Satellite Images
LTC John A. Marin, USMA/Dept of Systems Engineering

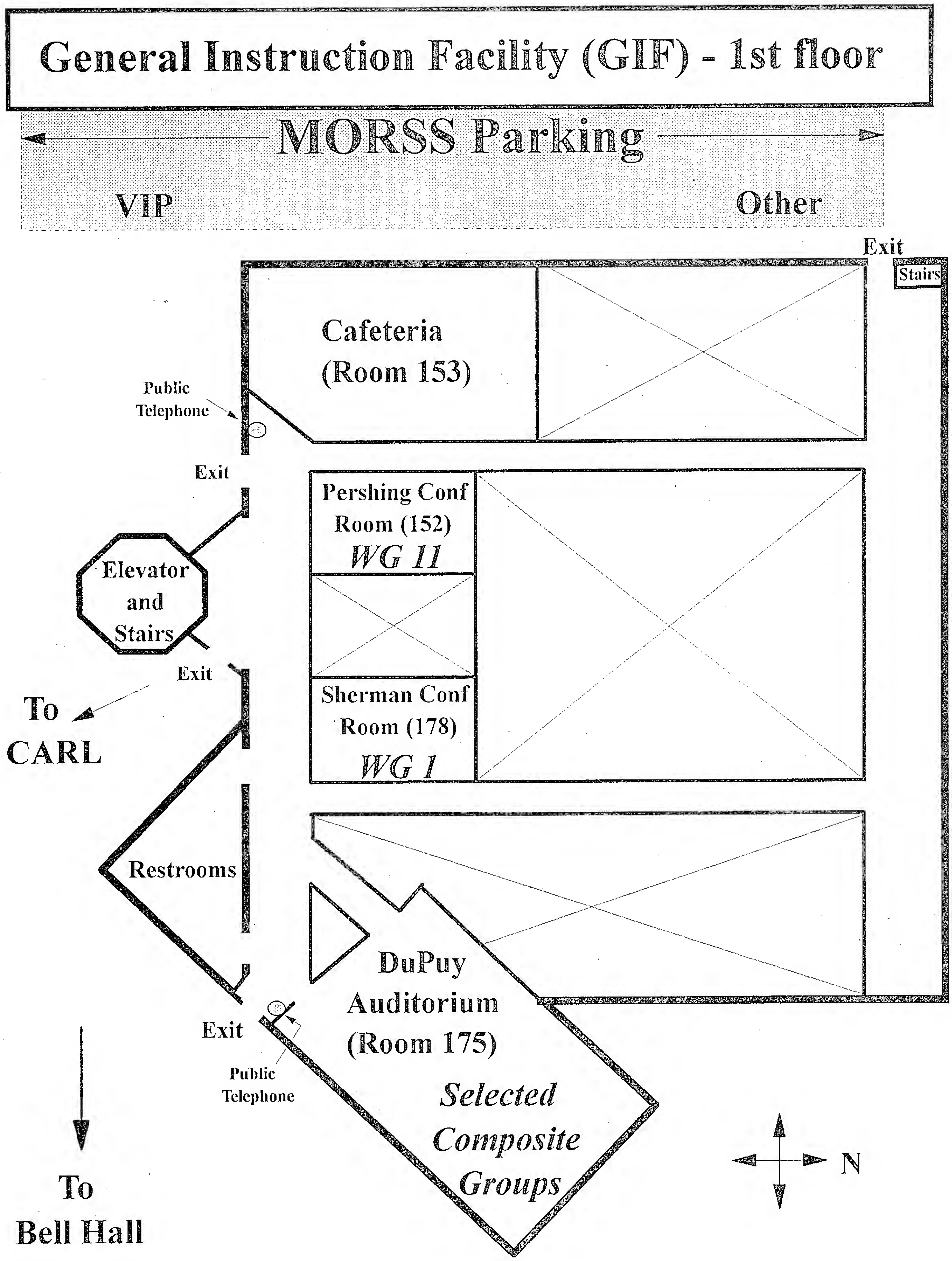
The Emerging DoD Hyper-Spectral Imagery (HSI) Initiative - A Challenge for Operations Research
Timothy Eveleigh, Autometric Inc

Thursday, 0830-1000
Reusable Spacelift Concepts Study (RSCS)
Capt Jeffrey Grobman and Christopher Feuchter, Office of Aerospace Studies (AFMC)

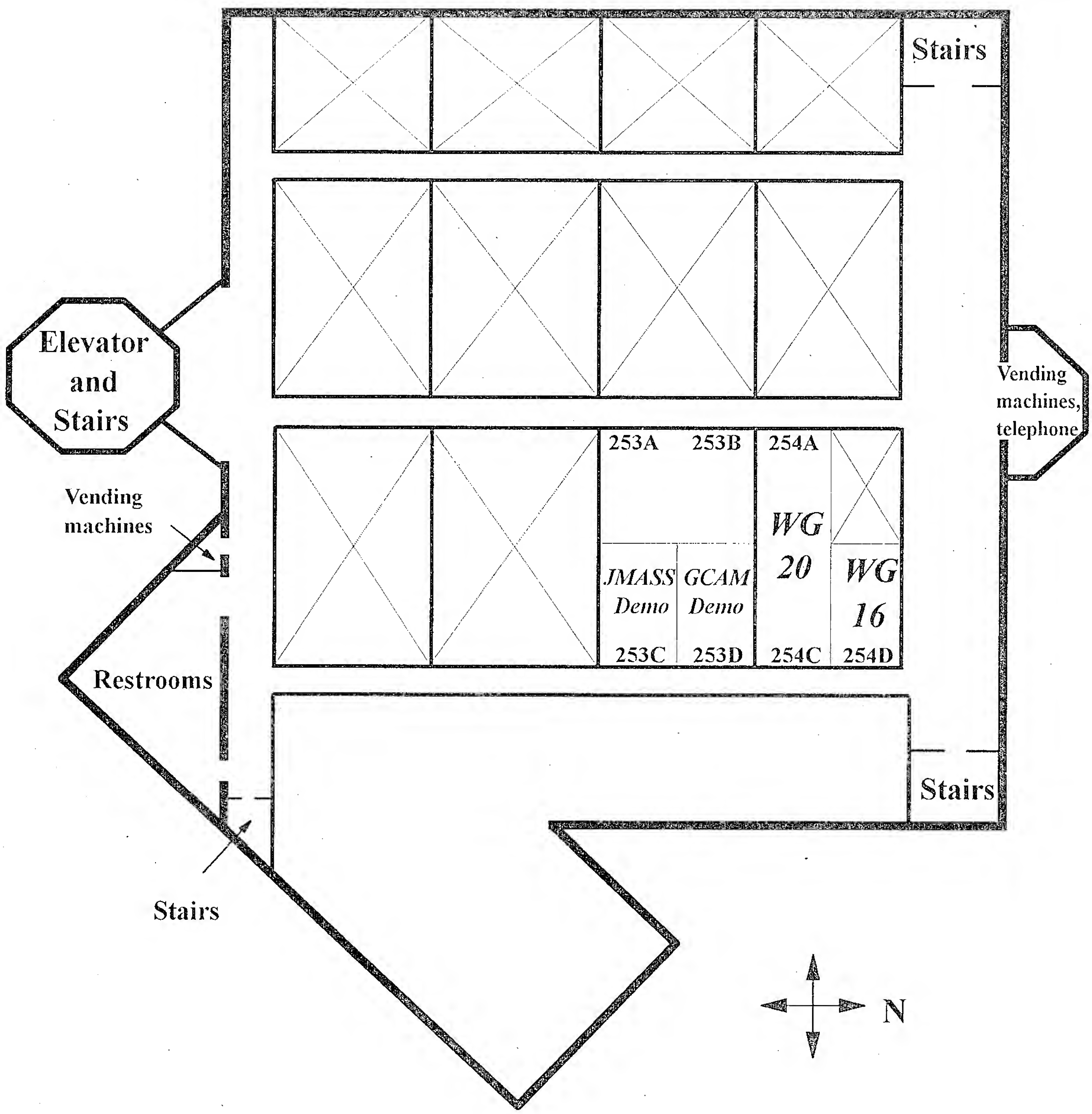
Assessing the Impact of Reusable Orbital Transfer Vehicles for Spacelift Modernization
Capt Tim Gooley, HQ AFOTEC and Capt Jeffrey Grobman, Office of Aerospace Studies (AFMC)

Thursday, 1330-1500
COMPOSITE GROUP IV SESSION .... Gif, Dupuy Auditorium


Bell Hall
(Ground floor)
To GIF
(Work Groups 1-33)
Exit
Classroom 1
Classroom 3
Classroom 5
Eisenhower Auditorium
(Opening Session)
Classroom 7
Classroom 9 (Attendees Support Office)
Classroom 11
Telephones, PCs, e-mail (telnet), fax, printers, work area
Foyer
Exit
Classroom 2 (Arnold Conf Rm)
Classroom 4
Classroom 6
WG 10
Restrooms
Door
Classroom 8 (MORS Office)
Classroom 10
Classroom 12
CAS3 Wing
Court Yard
Trophy Lounge
Marshall Auditorium
(Composite Group Room)
Porch
MORSS Registration, 0645-0900, Tue, 18 Jun
Horseshoe Drive
Door
CGSC Conf Room - 113
MacArthur Office - 111
N

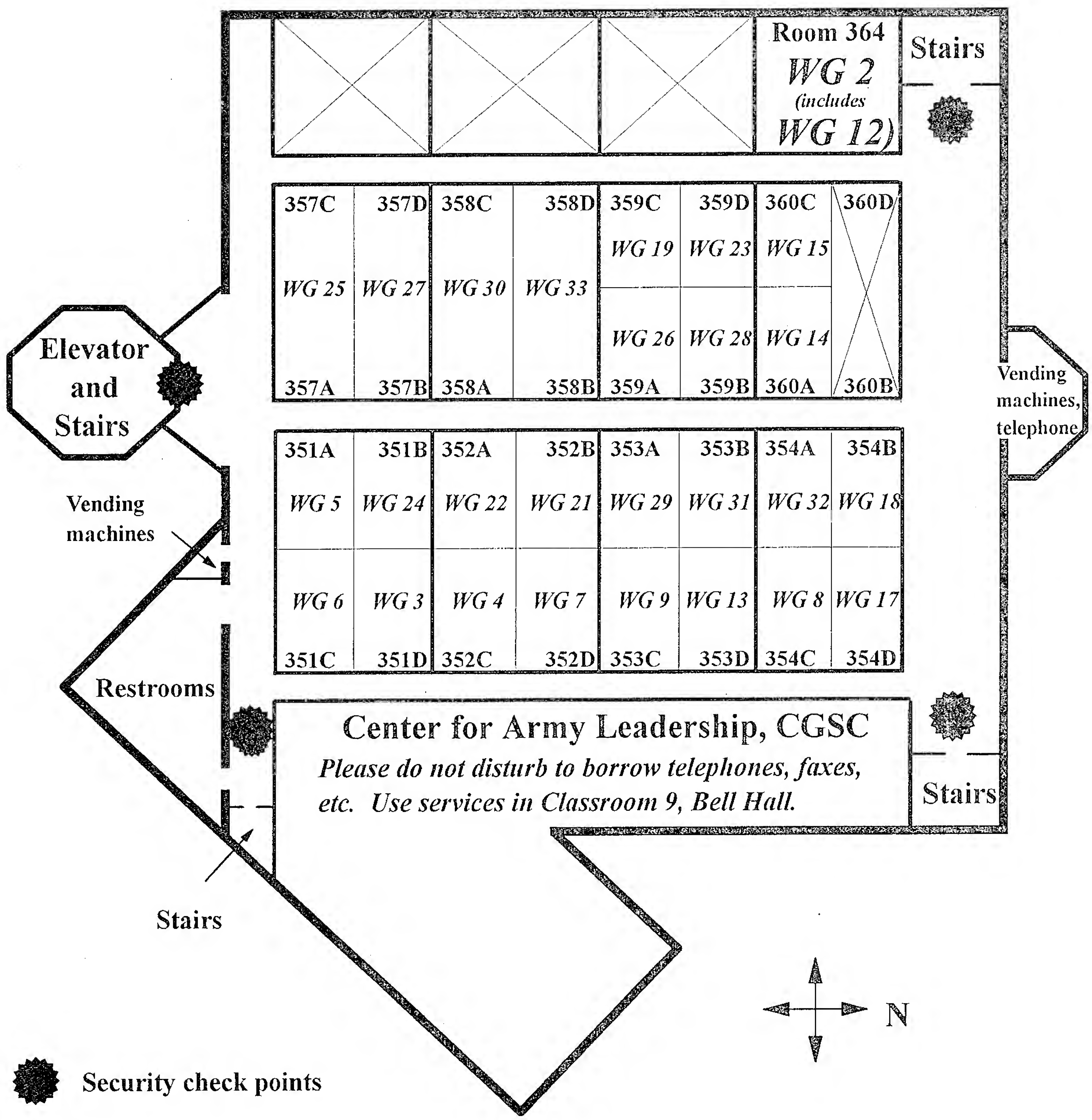

General Instruction Facility (GIF) - 1st floor
MORSS Parking
VIP
Other
Exit
Stairs
Cafeteria
(Room 153)
Public
Telephone
Exit
Pershing Conf
Room (152)
WG 11
Elevator
and
Stairs
Exit
To
CARL
Sherman Conf
Room (178)
WG 1
Restrooms
DuPuy
Auditorium
(Room 175)
Selected
Composite
Groups
Exit
Public
Telephone
N
To
Bell Hall

General Instruction Facility (GIF) - 2nd floor



General Instruction Facility (GIF) - 3rd floor

Entire 3d floor is secured for classified briefings



Bus Transportation from Hotels to Fort Leavenworth and Back

Day	*Depart Hotels*	*Arrive FLVN (Bell Hall)*	*Depart Bell Hall*	*Arrive Hotels*	*Arrive FCC (Mixer)*	*Depart Mixer*
Tuesday 18 June (4 buses)	0545 0700 0730	0635 0750 0820	1715 1715	1800 N/A	N/A 1720	N/A 1900
Wednesday 19 June (5 buses)	*Depart Hotels*	*Arrive FLVN (Bell Hall)*	*Depart Bell Hall*	*Arrive Hotels*	*Depart for BBQ*	*Depart BBQ*
	0545 0700 0730	0635* 0750** 0820	1700	1745	1800	2030/ 2100/ 2130
Thursday 20 June (4 buses)	*Depart Hotels*	*Arrive FLVN (Bell Hall)*	*Depart Bell Hall*		*Arrive Airport/Hotels*	
	0545 0700 0730	0635 0750 0820	1215, 1355, 1415, 1535, 1555, 1715, 1735		50 minutes later	

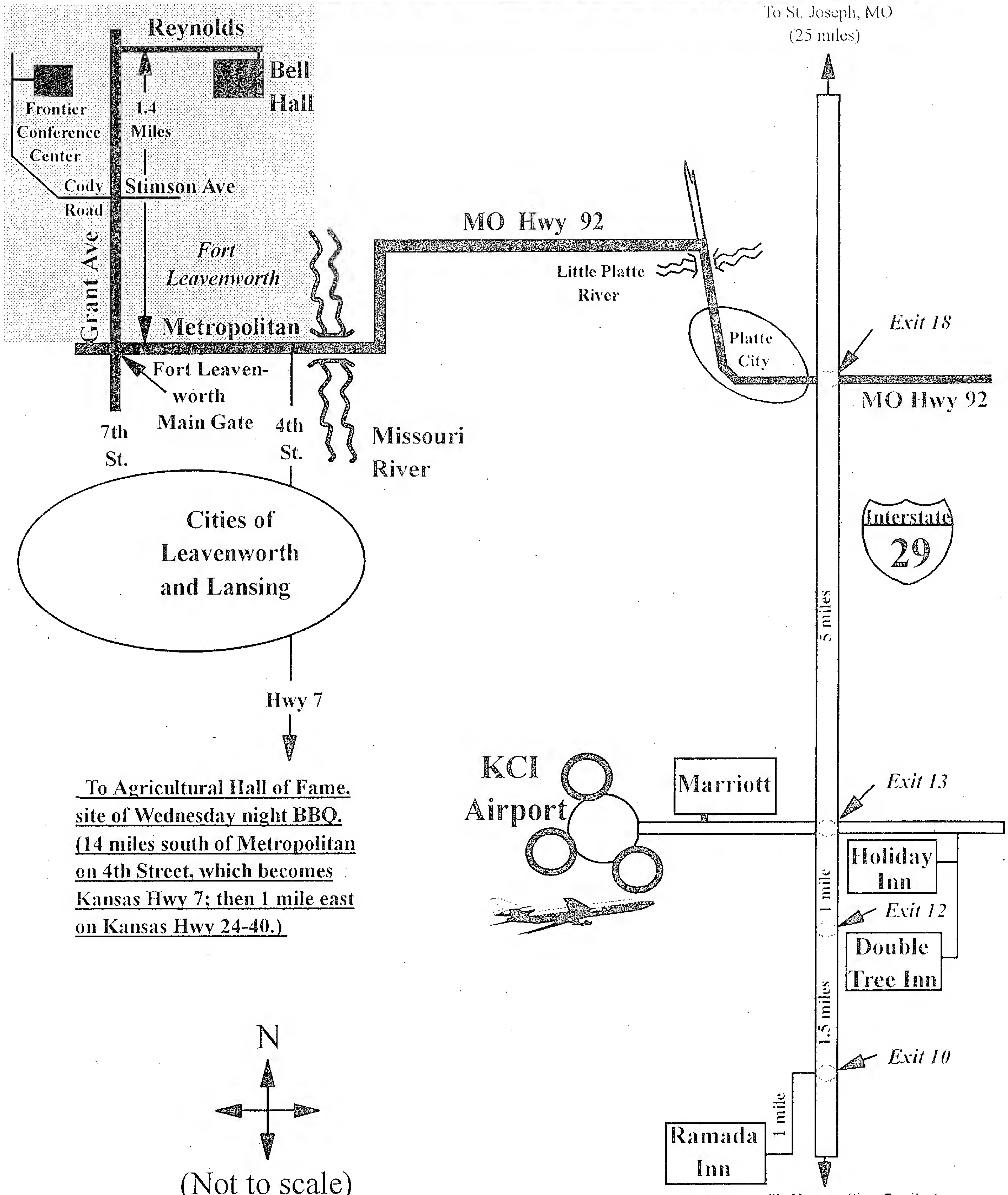
FLVN = Fort Leavenworth FCC = Frontier Conference Center (formerly FLVN Officers Club)

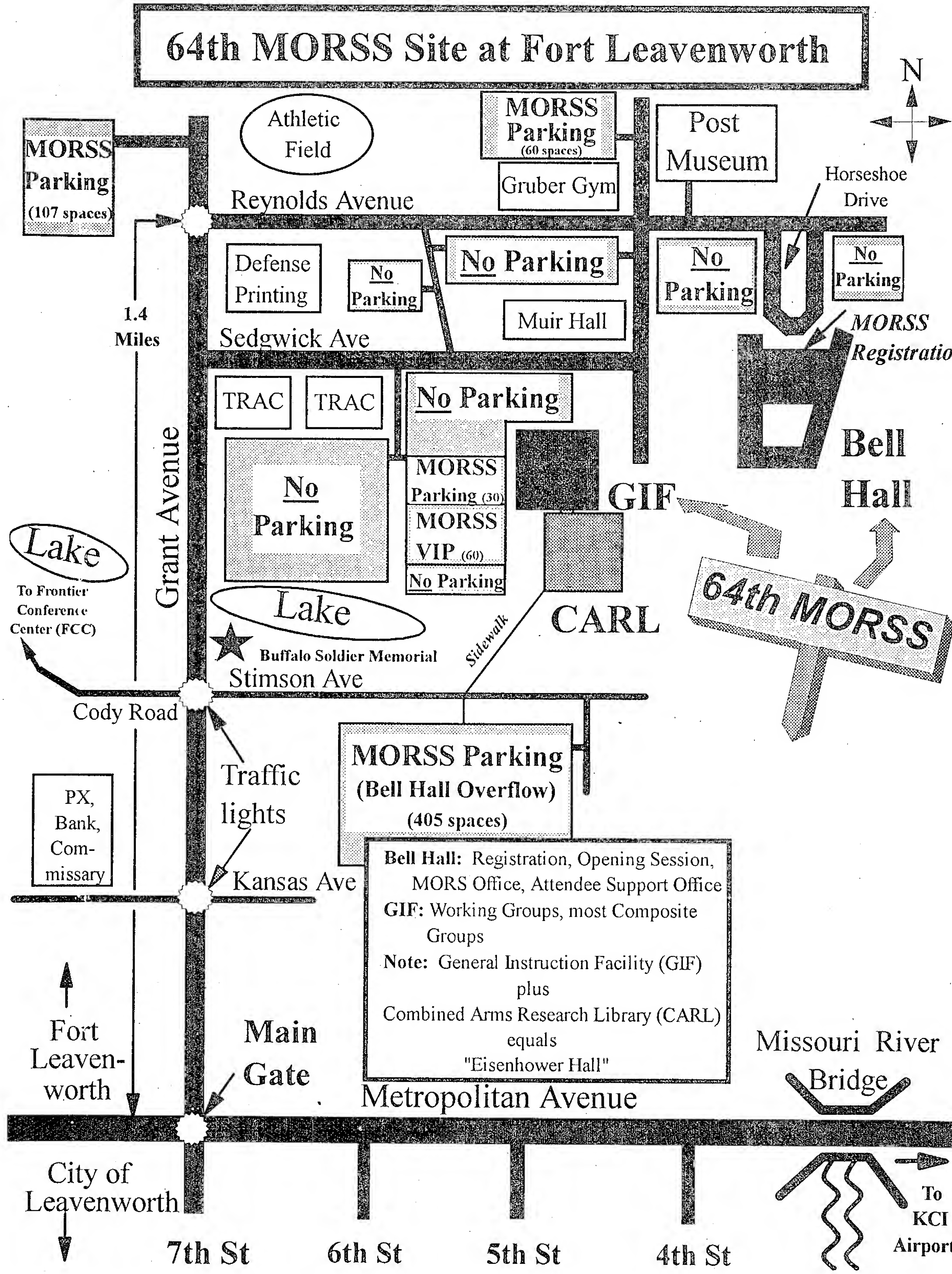
* Stops en route at FCC to drop off Working Group/Composite Group Chairmen for the Town Hall Meeting.

** After Bell Hall dropoff, buses go to FCC to retrieve WG/CG chairs at Town Hall Meeting, take them to Bell Hall.

NOTE: Two FLVN buses shuttle between Bell Hall and FCC each day for lunch, 1100-1400.

Route from KC Airport and Hotels to Fort Leavenworth




64th MORSS Site at Fort Leavenworth
N
Athletic Field
MORSS Parking (60 spaces)
Post Museum
MORSS Parking (107 spaces)
Gruber Gym
Horseshoe Drive
Reynolds Avenue
Defense Printing
No Parking
No Parking
No Parking
No Parking
Muir Hall
1.4 Miles
Sedgwick Ave
MORSS Registration
TRAC
TRAC
No Parking
Bell Hall
Grant Avenue
No Parking
MORSS Parking (30)
MORSS VIP (60)
No Parking
GIF
Lake
To Frontier Conference Center (FCC)
Lake
CARL
64th MORSS
Sidewalk
Buffalo Soldier Memorial
Stimson Ave
Cody Road
Traffic lights
MORSS Parking (Bell Hall Overflow) (405 spaces)
PX, Bank, Com-missary
Kansas Ave
Bell Hall: Registration, Opening Session, MORS Office, Attendee Support Office
GIF: Working Groups, most Composite Groups
Note: General Instruction Facility (GIF) plus Combined Arms Research Library (CARL) equals "Eisenhower Hall"
Fort Leaven-worth
Main Gate
Missouri River Bridge
Metropolitan Avenue
City of Leavenworth
To KCI Airport
7th St
6th St
5th St
4th St

The MORS Board of Directors and Symposium staff want to improve MORS symposia to better respond to your needs. Please evaluate the symposium sessions you attended and turn this assessment in to a working group chair, the MORS office, or mail to MORS, 101 S. Whiting St, #202, Alexandria, VA 22304 or FAX 703-751-8171.

EVALUATION OF 64TH MORS SYMPOSIUM					
	Poor	<	------	>	Excellent
1. Overall, how do you rate the 64th MORSS in meeting your needs?					
2. Overall, how do you rate the special session in meeting your needs?					
Please give your assessment of each special session attended.					
Special Session 1					
Leveraging Technology for the Military Analyst: Framing the Analysis					
A Workshop Report: Joint Mobility Analysis					
Meet the Editors					
Prize Paper Session					
Special Session 2					
Leveraging Technology for the Military Analyst: Dealing with Data					
A Workshop Report: Advanced Distributed Simulation for Analysis					
Junior/Senior Analyst Session					
Special Session 3					
Leveraging Technology for the Military Analyst: Interfacing with Tools					
Information Warfare and Deterrence					
Readiness: Keeping the Force Ready to Fight					
Education Session					
Special Session 4					
Leveraging Technology for the Military Analyst: Conducting the Analysis					
A Task Force Report: Advanced Battlespace Information System Task Force					
3. Overall, how do you rate the poster session in meeting your needs?					
4. Overall, how do you rate the tutorial session in meeting your needs?					
Please give your assessment of each tutorial session you attended.					
Using Values to Generate Alternatives					
Value-Focused Thinking					
Modeling for Campaign Analysis: Lessons for the Next Generation of Models					
Using DTIC to Publish MORS Papers					
MASTR (Modeling, Analysis, Simulation and Training), A New Look					
Lanchester on Lanchester Intelligence					
Operational Effectiveness Analyses for Systems That Don't Shoot					
Determining the Force Structure Trade Space, Specifically Addressing ISR, DBA					
Modeling Joint Mobility Problems: A Tutorial					
5. Overall, how do you rate the working groups in meeting your needs:					
Please give your assessment of the working groups you attended.					
1st Working Group Session WG# ______					
2nd Working Group Session WG# ______					
3rd Working Group Session WG# ______					
4th Working Group Session WG# ______					
5th Working Group Session WG# ______					
6th Working Group Session WG# ______					
7th Working Group Session WG# ______					
6. Overall, how do you rate the composite group in meeting your needs?					
Please give your assessment of the composite groups you attended.					
Composite Group I: Strategic					
Composite Group II: Naval Warfare					
Composite Group III: Airland Contingency Operations					
Composite Group IV: Space/C3I					
Composite Group V: Research and Development					
Composite Group VI: Resources and Readiness					
Composite Group VII: Methodologies and Technologies					
Please provide any additional comments.					

PRINT NAME (Optional): ______________________________

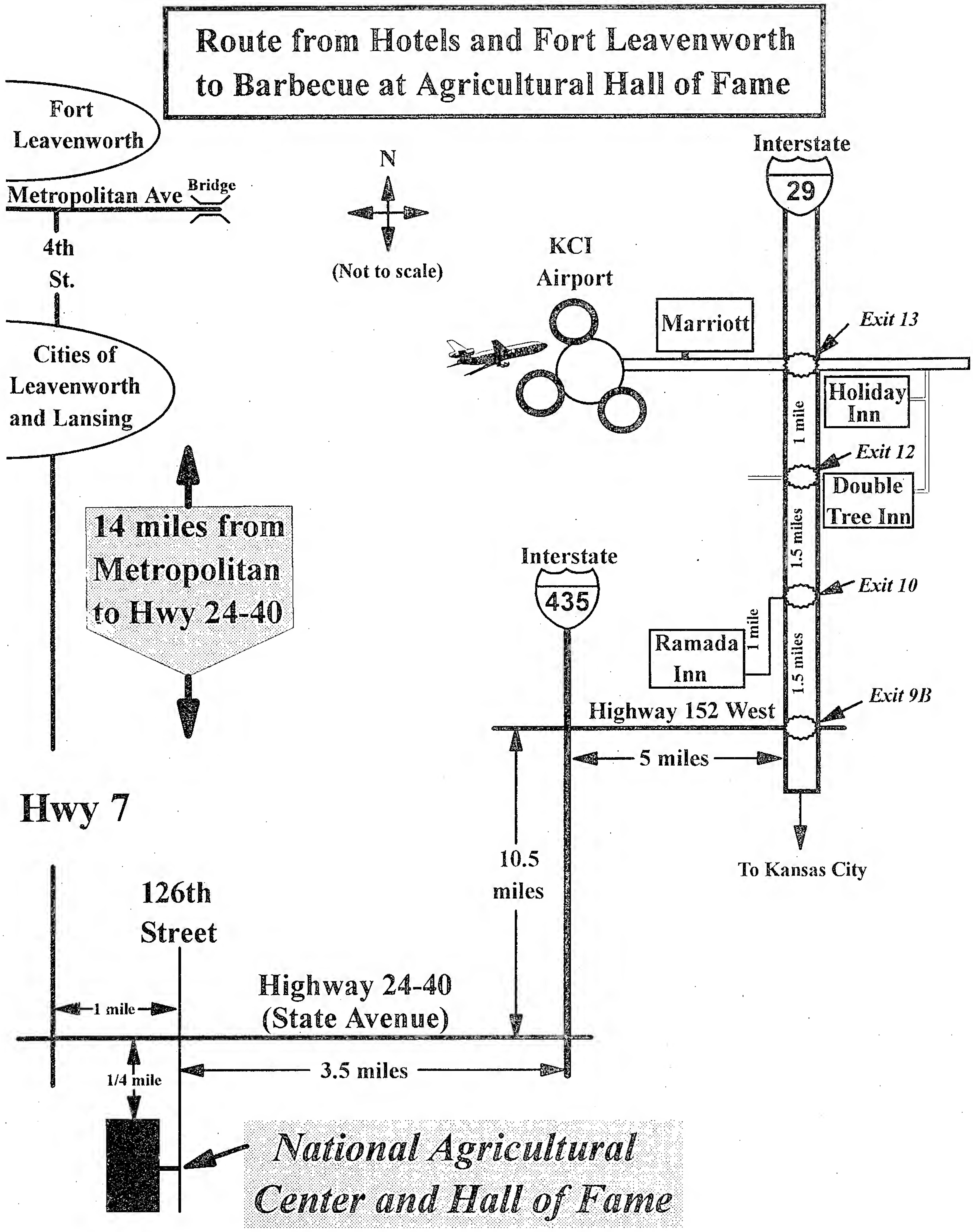
The 64th Military Operations Research Society Symposium at a Glance

DAY: TIME: SESSION NR:	TUE 0715-0815 W-U 1	TUE 0830-1000 PL	TUE 1030-1200 1	TUE 1200-1330 LT 1	TUE 1330-1500 SS 1	TUE 1530-1700 2	TUE 1715-1800 M	WED 0700-0800 TH	WED 0830-1000 3	WED 1030-1200 SS 2	WED 1200-1330 LT 2	WED 1330-1500 4	WED 1515-1645 5	WED 1830-2130 WBB	THUR 0830-1000 6	THUR 1030-1200 SS 3	THUR 1200-1330 LT 3	THUR 1330-1500 7	THUR 1500-1530 W-U 2	THUR 1530-1700 SS 4
CG I						Dupuy														
WG 1	W	P	178	L	S	Dupuy	M	T	178	S	L	178	178	W	178	S	L		W	S
WG 3	G	L	351D	U	P	Dupuy	I	O	351D	P	U	351D	351D	E	351D	P	U	351D	G	P
WG 4	/	E	352C	N	E	Dupuy	X	W	352C	E	N	352C	352C	S	352C	E	N	352C	/	E
CG II	C	N	Dupuy	C	C		E	N		C	C			T		C	C		C	C
WG 5	G	A	Dupuy	H	I	351A	R		351A*	I	H	351A	351A	E	351A*	I	H	351A	G	I
WG 6		R	Dupuy	/	A	351C		H	351C*	A	/	351C	351C	R	351C*	A	/	351C		A
CG III	C	Y		T	L		I	A		L	T	MAR		N		L	T		C	L
WG 2	H		364	U		364		L	364		U	MAR	364		364		U	364	H	
WG 7	A	I	352D	T	S	352D	F	L	352D	S	T	MAR	352D	B	352D	S	T	352D	A	S
WG 8	I		354C	O	E	354C	R		354C	E	O	MAR	354C	B	354C	E	O	354C	I	E
WG 9	R	E	353C	R	S	353C	O	I	353C	S	R	MAR	353C	Q	353C	S	R	353C	R	S
WG 10		I	CR6	I	S	CR6	N		CR6	S	I	CR6	CR6		CR6	S	I	CR6		S
WG 11	C O	S E	152	A L	I	152	T I	F R	152	I O	A L	152	FUN	I	152	I O	A L	152	C O	I O
WG 13	I	N	353D	S	N	353D	E	O	353D	N	S	MAR	353D	A	353D	N	S		I	N
WG 14	C	H	360A	(2)		360A	R	N	Dupuy		(2)	MAR	360A	G	360A		(2)	360A	C	
CG IV	H	O			1			T		2				R		3		Dupuy	H	4
WG 15	A	W	360C		(3)	360C	C	I	360C	(4)		360C	360C	I	360C	(5)		Dupuy	A	(7)
WG 16	I	E	254D			254D	O	E	254D			254D	254D	C	254D			Dupuy	I	
WG 17	R	R	354D			354D	N	R	354D			354D	354D	U	354D			Dupuy	R	
WG 18			354B			354B	F		354B			354B	354B	L	354B			Dupuy		
CG V	W	A					E	C						T	Dupuy				W	
WG 19	A	U	359C			359C	R	O	359C			359C	359C	U	Dupuy			359C	R	
WG 20	R	D	254 A&C			254 A&C	E	N	254 A&C			254 A&C	254 A&C	R	Dupuy			254 A&C	A	
WG 21	M	I	352B			352B	N	F	352B			352B	352B	A	Dupuy			352B	P	
WG 22	I	T	352A			352A	C	E	352A			352A	352A	L	Dupuy				I	
WG 23	U	O	359D			359D	E	R	359D			359D	359D		Dupuy				U	
CG VI	P	R						E					Dupuy	H					P	
WG 24	(1)	I	351B			351B	C	N	351B			351B	Dupuy	A	351B			351B	(6)	
WG 25		U	357 A&C			357 A&C	E	C	357 A&C			357 A&C	Dupuy	L	357 A&C			357 A&C		
WG 26		M	359A			359A	N	E	359A			359A	Dupuy	L	359A			359A		
WG 27			357 B&D			357 B&D	T		357 B&D			357 B&D	Dupuy		357 B&D			357 B&D		
WG 28		B	359B			359B	E	C	359B			359B	Dupuy	O	359B			359B		
WG 29		E	353A			353A	R	E	353A			353A	Dupuy	F	353A					
CGVII		L						N	MAR											
WG 30		L	358 A&C			358 A&C		T	MAR			358 A&C	358 A&C	F	358 A&C			358 A&C		
WG 31			353B			353B		E	MAR			353B	353B	A	353B			353B		
WG 32		H	354A			354A		R	MAR			354A	354A	M	354A			354A		
WG 33			358 B&D			358 B&D			MAR			358 B&D	358 B&D	E	358 B&D			358 B&D		

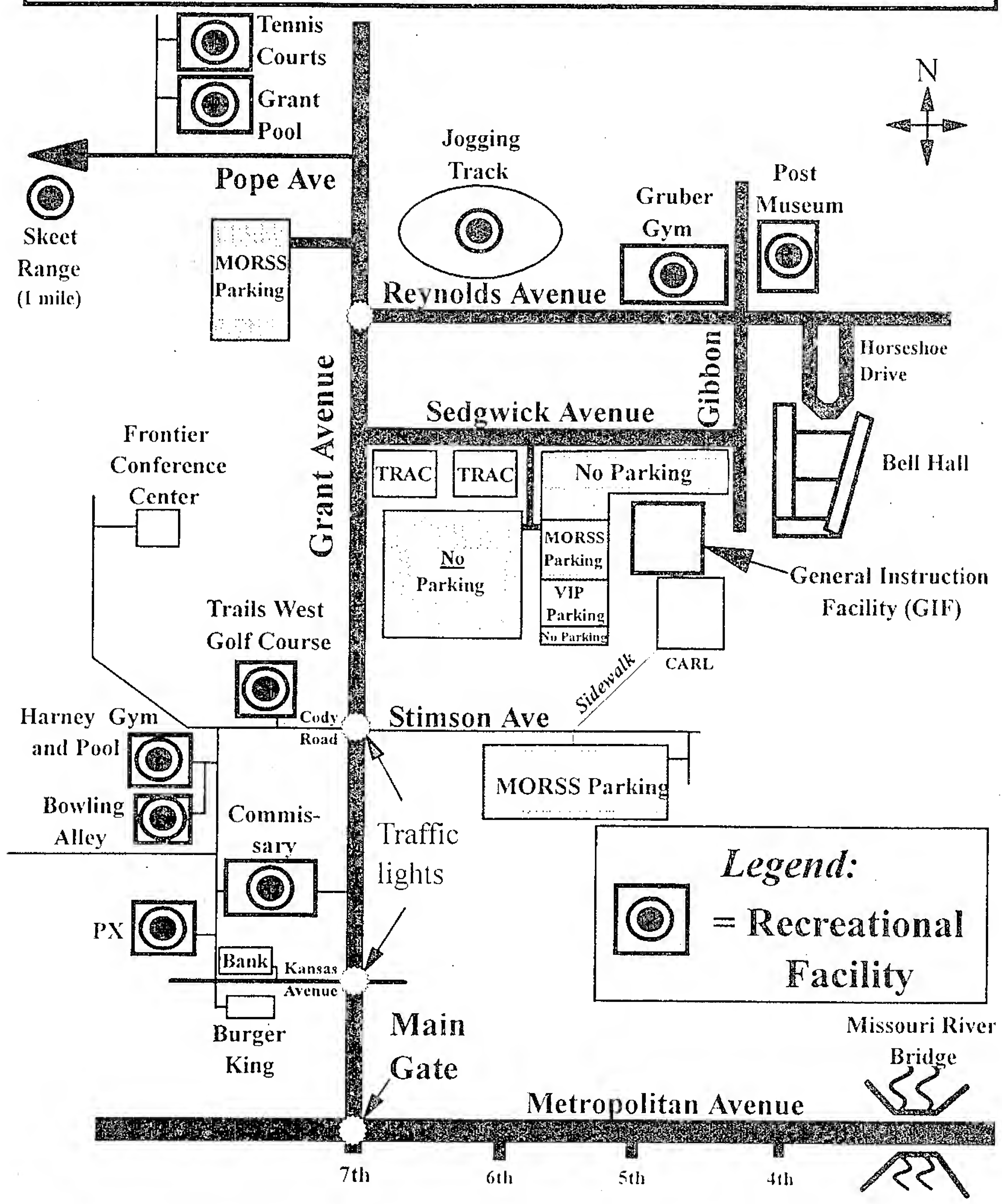
NOTES: Eisenhower and Marshall Auditoriums and Classroom 8 (CR8) are in Bell Hall; all others are in the General Instruction Facility (GIF).

1. Warm-up in Marshall Auditorium.
2. Tutorial Schedule is on page 9-11.
3. Special Session 1 Schedule is on page 1-3.
4. Special Session 2 Schedule is on page 3-4.
5. Special Session 3 Schedule is on page 5-7.
6. Wrap-up in Classroom 6, Bell Hall
7. Special Session 4 Schedule is on page 8.

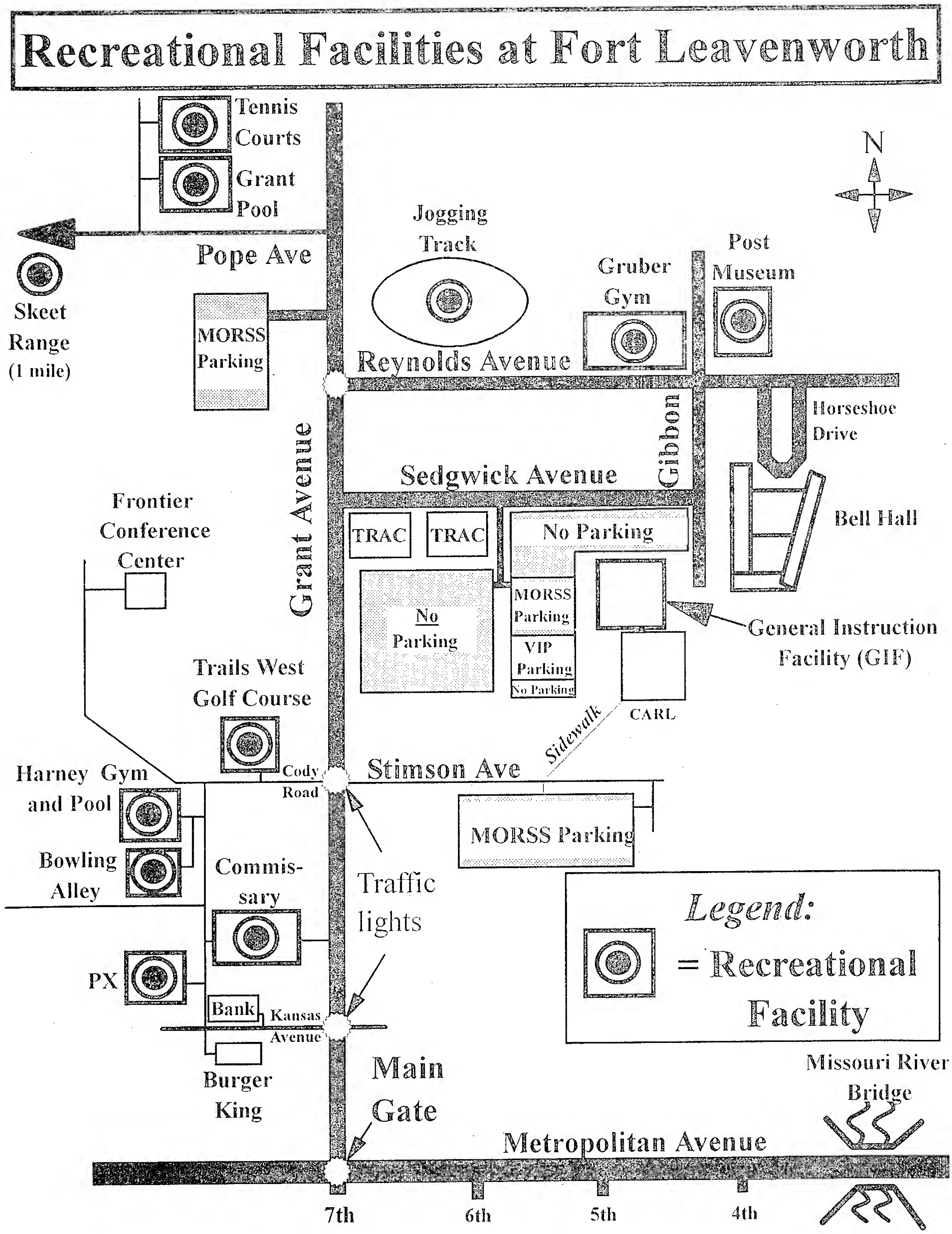
*** Joint Session** **+ MAR = Marshall Auditorium** **+ FUN = Funston Hall Conference Room**


Route from Hotels and Fort Leavenworth
to Barbecue at Agricultural Hall of Fame
Fort Leavenworth
Metropolitan Ave
Bridge
4th St.
Cities of Leavenworth and Lansing
14 miles from Metropolitan to Hwy 24-40
Hwy 7
126th Street
1 mile
1/4 mile
Highway 24-40 (State Avenue)
3.5 miles
National Agricultural Center and Hall of Fame
N
(Not to scale)
KCI Airport
Marriott
Interstate 29
Exit 13
Holiday Inn
1 mile
Exit 12
Double Tree Inn
1.5 miles
Exit 10
Ramada Inn
1 mile
1.5 miles
Exit 9B
Interstate 435
Highway 152 West
5 miles
10.5 miles
To Kansas City

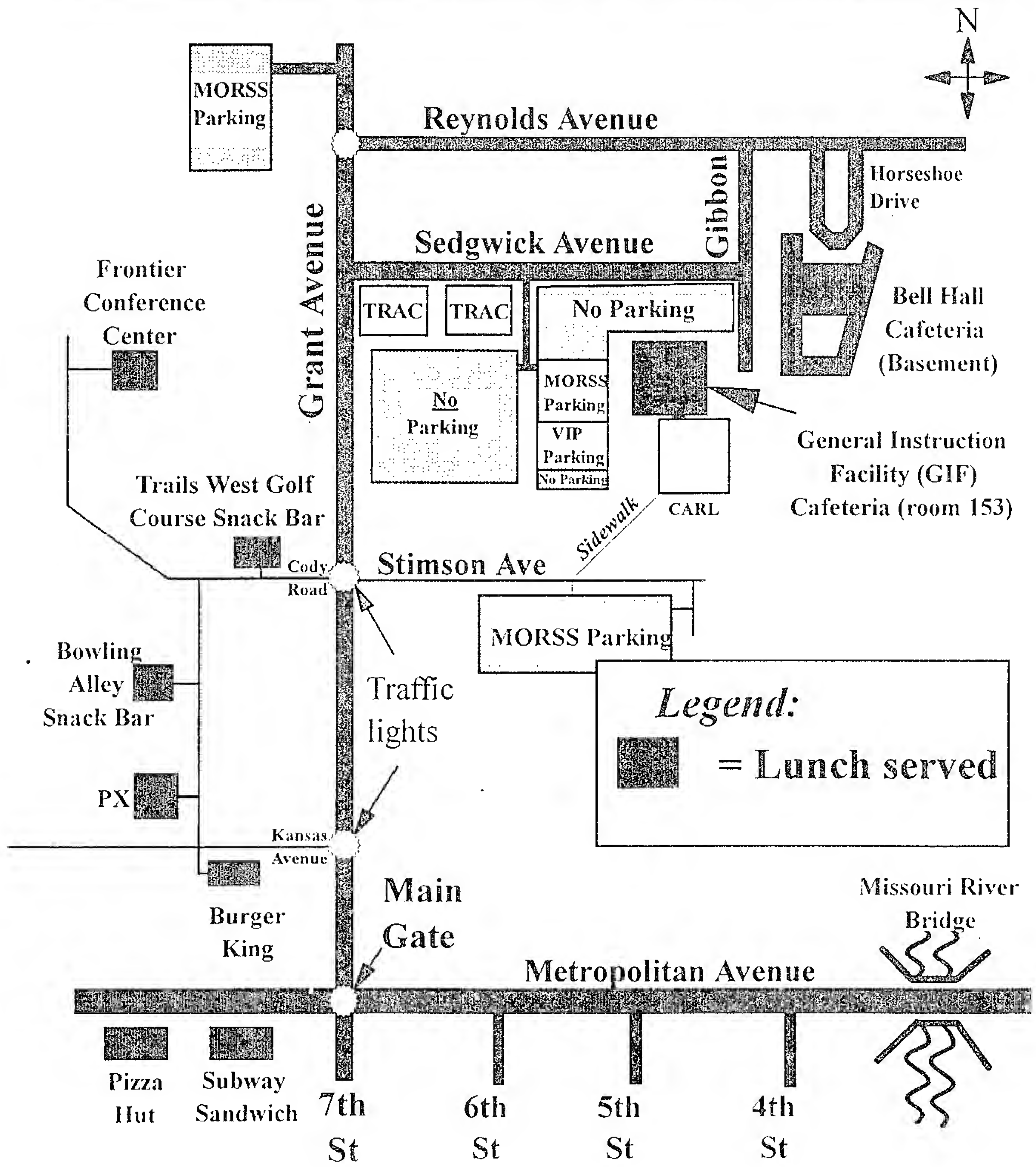
Recreational Facilities at Fort Leavenworth



Facility	Operating hours	Telephone
Trails West Golf Course	0730-dusk	684-3994
Grant Pool (out-of-doors)	1000-2000 (T)	684-3998
Gruber Gym (weights, basketball, handball, racquetball, squash, sauna, steam)	0630-2200	684-5120
Harney Gym (racquetball, handball, squash, volleyball, basketball--**no weights!**)	0630-2200	684-2037
Harney Gym Indoor Swimming Pool	Call for schedule	684-2187
Bowling Alley	1100-2000	684-2695
PX	0900-2100	651-7271
Commissary	1000-1800 (closed Mon)	684-4903
Post Museum/Gift Shop	0800-1600	684-3767
Skeet Range	Wed: 1200-1530 / Thur: 1700-2030	651-8132
Tennis Courts	Daylight-2000	--none--

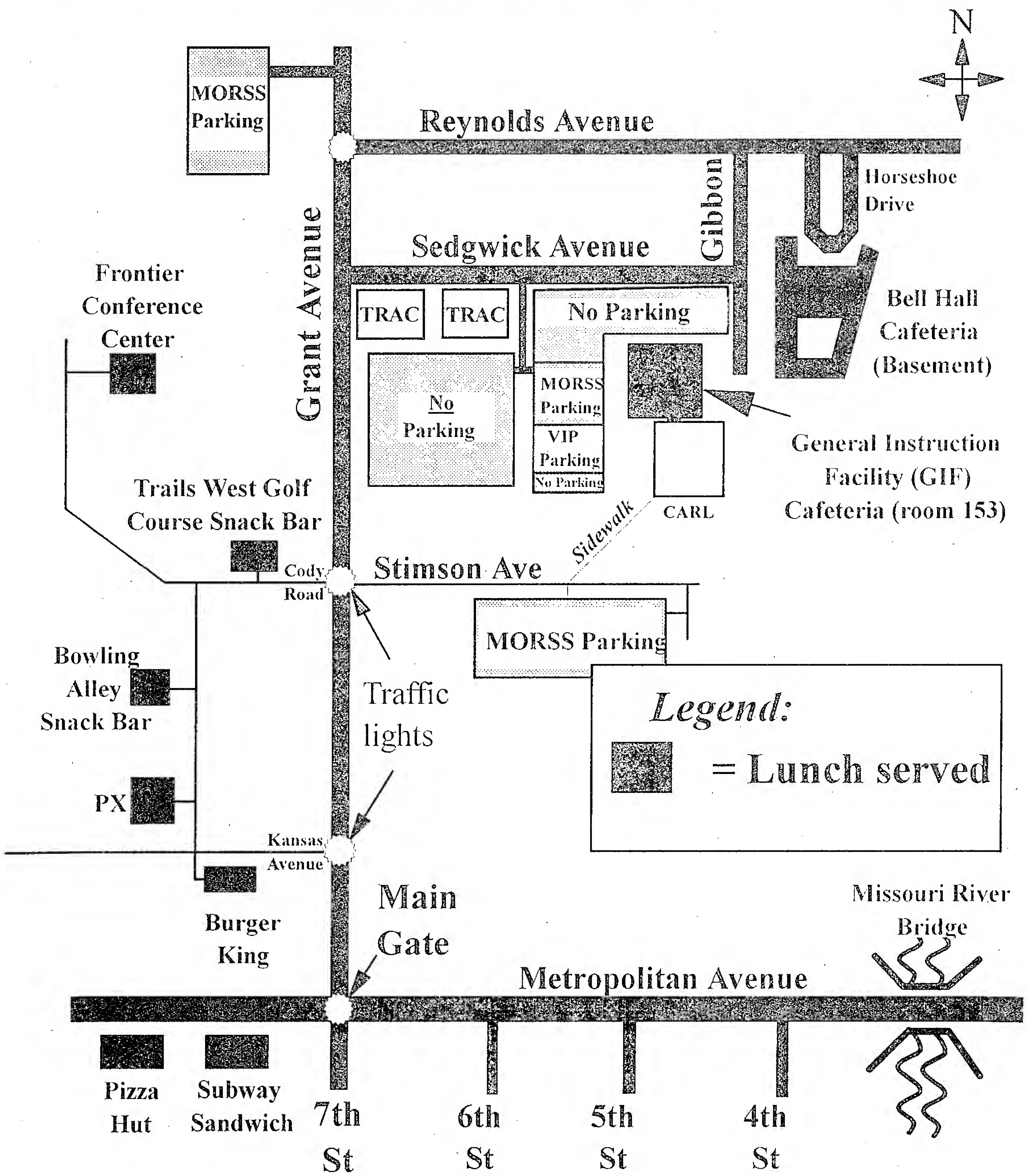

Recreational Facilities at Fort Leavenworth
Tennis Courts
Grant Pool
Skeet Range (1 mile)
Pope Ave
Jogging Track
Gruber Gym
Post Museum
MORSS Parking
Reynolds Avenue
Horseshoe Drive
Gibbon
Sedgwick Avenue
Grant Avenue
Bell Hall
Frontier Conference Center
TRAC
TRAC
No Parking
No Parking
MORSS Parking
VIP Parking
No Parking
General Instruction Facility (GIF)
Trails West Golf Course
CARL
Sidewalk
Harney Gym and Pool
Cody Road
Stimson Ave
MORSS Parking
Bowling Alley
Commis-sary
Traffic lights
Legend:
= Recreational Facility
PX
Bank
Kansas Avenue
Burger King
Main Gate
Missouri River Bridge
Metropolitan Avenue
7th
6th
5th
4th

Lunch Facilities at Fort Leavenworth

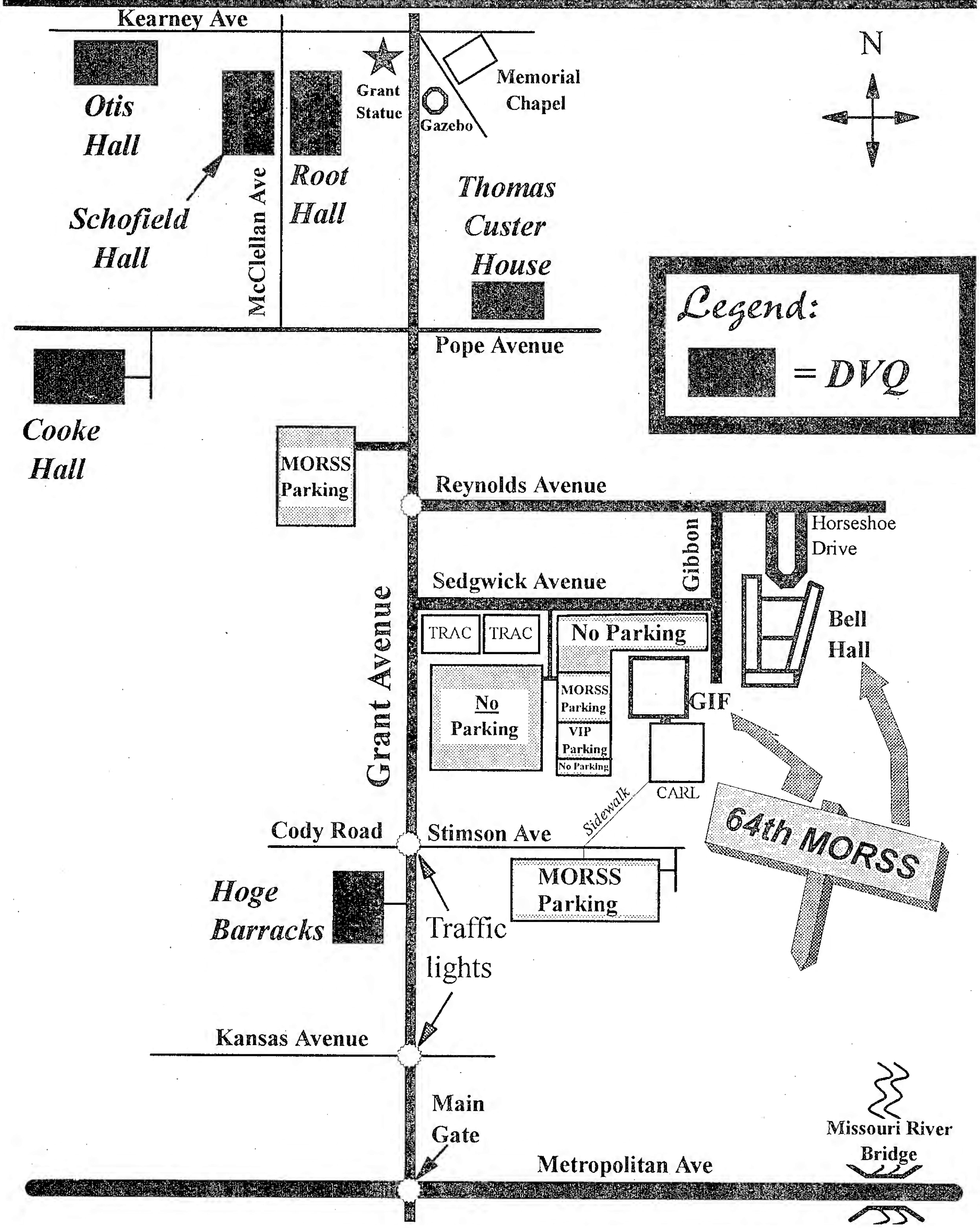


Lunch Facility	Operating Hours
Bell Hall Cafeteria	0630-1500
GIF Cafeteria	0630-1500
Frontier Conference Center	1100-1400 (closed Monday)
Trails West Golf Course Snack Bar	0900-dusk
Bowling Alley Snack Bar	1100-2200
PX Snack Bar	1100-2100
Burger King	0630-2100
Pizza Hut	1100-2200
Subway Sandwich	0900-2000

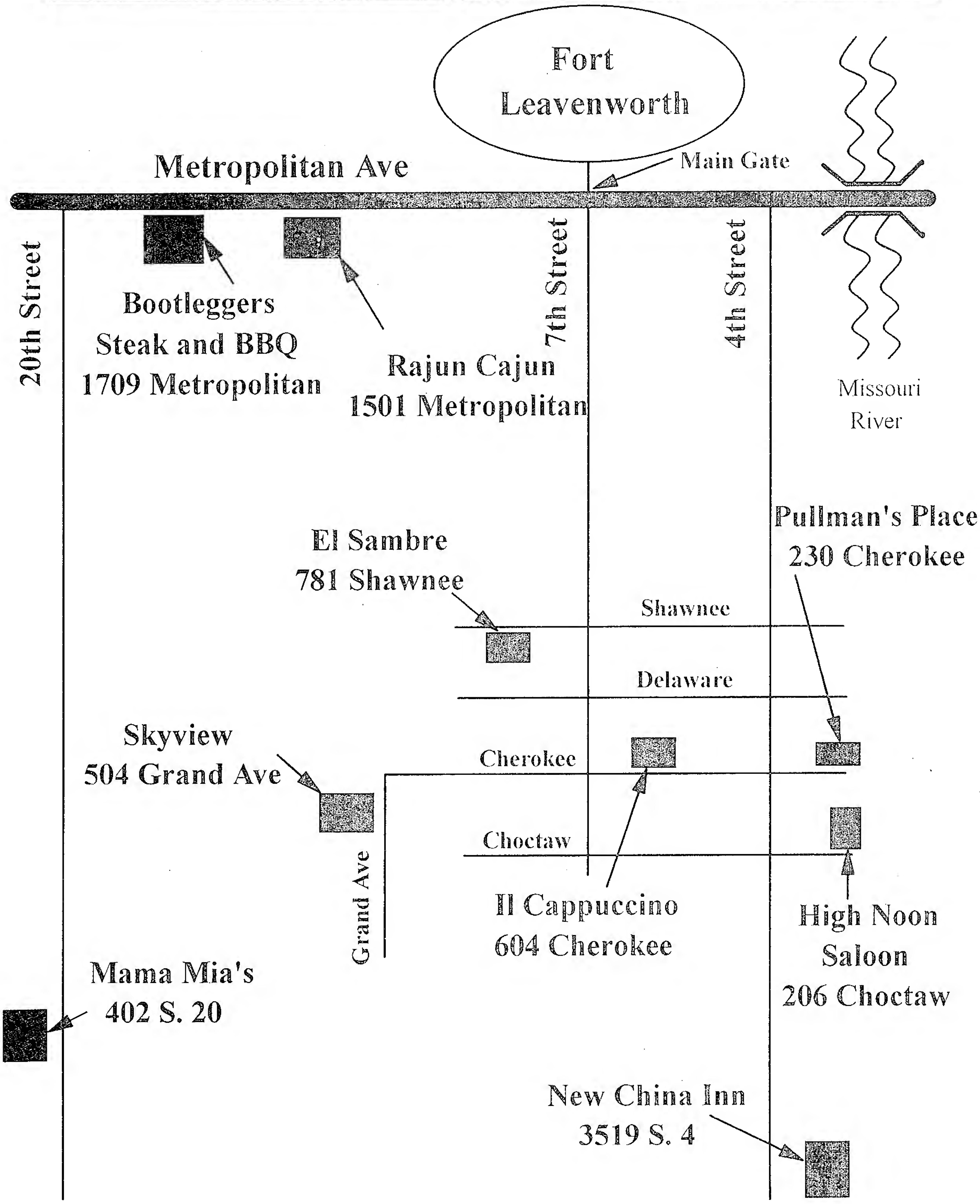
Lunch Facilities at Fort Leavenworth



Distinguished Visitors Quarters (DVQ) at Fort Leavenworth



Some Restaurants in Leavenworth



WG 17 - OPERATIONAL CONTRIBUTION OF SPACE SYSTEMS - Abstracts

Tuesday, 1030-1200
The Cost of Doing War

Oliver Cathey
SPARTA, Inc
23401 Avenida de la Carlota, Suite 325
Laguna Hills, CA 92653-1507
(714) 583-2370 FAX -9114
ollie_cathey@qmail.laguna.sparta.com

1Lt Shawn Baerlocher
SMC/XRER
2420 Vela Way, Suite 1467-80
Los Angeles AFB, CA 90245-4659
(310) 363-8649 FAX -8650
baerlocher@m105x4.laafb.af.mil

Calculating the Cost of Execution (COE) for a Major Regional Conflict (MRC) independent of victory or loss provides a method of determining a Return on Investment (ROI) across a wide range of dissimilar military missions and systems. The methodology described in this presentation portrays the USAF's tasks in a MRC as being the destruction of a prescribed target set and addresses the question "How long does it take and how much does it cost to generate and fly the sorties required to destroy those targets?" The COE includes the cost of logistics, surveillance, generation of Air Tasking Orders (ATO), airbase operations, fuel, weapons, spare parts and losses based on nominal attrition rates. Although the methodology is more complex than this abstract might make it seem, it remains simple enough for implementation in a spreadsheet model which provides a forum for the examination of reactive scenarios and the quick evaluation of ROI for new military systems and concepts. SMC/XRE has been sponsoring the development of a campaign level COE spreadsheet analysis tool kit for use in the evaluation of future space systems. This presentation will describe the fundamentals and underlying assumptions of the COE methodology. Several examples of XRE space system evaluations are provided as illustrations including ROI for a space based surveillance application to offensive counter-TBM operations (SCUD hunting).

Space Impact Assessment Methodology (SIAM) Study

Paul Szymanski
Aegis Research Corporation
2501 Buena Vista Drive, SE
Suite 400
Albuquerque, NM 87106
(505) 843-9122

A methodology was developed to identify and quantify the battlefield impacts of information that is provided from/through space systems. This methodology quantifies how space systems contribute to the information required by an adversary to achieve his warfighting objectives. It attempts to provide a definitive answer to the "why should I worry about space?" question. By its nature, the methodology has broad applicability to all types of information systems analyses, such as:

1. Quantification of the utility of space to potential U.S. adversaries.
2. Quantification of the utility of space to U.S. forces, to influence budgetary decisions, and determine survivability resource allocations according to space system value.
3. Possible input to intelligence collection prioritization, by showing which adversary systems are most important to his war effort.
4. As an input to models, simulations, and wargames of space and terrestrial systems performance.
5. Information warfare analyses of critical nodes and pathways.
6. Timing comparisons of U.S. vs. adversary C^4I processes to ensure the U.S. is always quicker than an adversary's ability to respond.
7. Timing analyses of when is the best time to strike an adversary's C^4I processes.
8. Timing analyses of what is the optimum time a U.S. asset should be transported into theater, to optimize military airlift schedules.
9. Target determination optimized for time, location, phase of battle, and most critical node.

Tuesday, 1530-1700
Air Force Space Command's New Vector

Lt Col Thomas Wiederrecht
HQ AFSPC/XPA
150 Vandenberg Street, Suite 1105
Peterson AFB, CO 80914-4570
(719) 554-4000twiederr@spacecom.af.mil

In October 1995, Air Force Space Command created a new division to exercise leadership in space Modeling, Simulation, and Analysis (MS&A). This division was formed as a result of the 4-star "New Vector" initiative. Specifically the organization will: provide Space MS&A policy/guidance, provide centralized visibility of AF Space MS&A, and establish a process to prioritize requirements and allocate resources. The division will also establish and enforce standards, and develop Air Force Space Investment Strategy for MS&A. The presentation will include the division's charter and actions to date.

Air Campaign Utility Analysis of GPS Guided Munitions

Capt David Lucia
Space Warfare Center/AEW
730 Irwin Ave, Suite 83
Falcon AFB, CO 80912-7383
(719) 567-9286 FAX -9496
luciadj@fafb.af.mil

This paper quantifies the utility of Wide Area GPS Enhancement (WAGE) GPS precision munitions to a notional Air Campaign in the South West Asia (SWA) Theater. Three Air Forces are sent to destroy a certain subset of the target types identified in SWA. The first Air Force is equipped with Laser/Terminally guided munitions and "dumb" bombs. The second Air Force has Regular GPS guided munitions with a CEP

of 13 meters along with Laser/Terminally guided munitions and dumb "bombs". The third Air Force has WAGE GPS guided munitions with a CEP of 2.5 meters, Laser/Terminally guided munitions, and dumb "bombs". An iterative simulation was developed to conduct the air campaign one target type at a time for each of the three Air Forces. Weather is included in the simulation which uses the validated SWA target and weapon system database to determine target kills per sortie per target type. The analysis primarily determines the total days to kill 50% of the identified targets for each of the three Air Forces. In addition, the analysis measures total number of sorties, and aircraft attrition by target type for each Air Force. The results for each target type are averaged together to estimate the effects of WAGE GPS on an Air Campaign.

Space Play in Theater Level Models

Capt Robert Payne
Air Force Institute of Technology/ENS
Bldg 640, 2950 P St
Wright-Patterson AFB, OH 45433
513-255-2549 FAX 513-476-4943
rpayne@afit.af.mil

This presentation will detail the amount of space representation in several of the more widely used theater level models. The models studied were the Tactical Warfare model (TACWAR), Janus, the Joint Level Simulation (JTLS), the Integrated Theater Engagement Model (ITEM), the Extended Air Defense Simulation (EADSIM), Thunder, and the ALSP confederation. While the ALSP confederation is not a model but a communications protocol, is was studied because of its future importance in the modeling community. Each model was evaluated according to how each space function and task, as described by the Spacecast 2020 report, is represented. Charts were developed for side-by-side comparison of each model.

Wednesday, 0830-1000
Military Utility-Based Space Force Mix Optimization Using Analytical Hierarchy Process

Maj David Taylor
Space Warfare Center/AEW
730 Irwin Ave, Suite 83
Falcon AFB, CO 80912-7383
(719) 567-9286 FAX -9496
taylordg@fafb.af.mil

The hierarchical nature of the Analytical Hierarchy Process (AHP) has a tremendous intuitive appeal to both modelers and system architects as a framework for computing military utility and optimizing a space force mix. Major Taylor proposes using AHP for studying of the effectiveness of space control, application, enhancement and support operations in the context of Air Campaigns. His goal is to understand and evaluate military utility using well-defined measures of merit that offer a norm against which potential network architectures can be compared. Using a prototype air campaign analysis to study the military utility of GPS guided munitions, Major Taylor will describe all significant steps in the model-building process -- defining measures of effectiveness (MOEs) and assigning weights, acquiring MOE values using simulation, and executing AHP with spreadsheets.

Non-Linear Dynamic Military Utility Analysis Technique

Capt David Lucia
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Capt. Lucia will present a concept to streamline the ability to analyze the military utility of new and emerging technologies in the context of an Air Campaign. The motivation for Capt. Lucia's research is to pioneer a method of conducting military utility studies that can be accomplished by one or two analysts in a period of a few weeks, yet yield results comparable to more involved studies requiring a large group of analysts/programmers several months to accomplish. The presentation will cover a brief description of discrete non-linear differential equations followed by a survey of mathematical models based on non-linear differential equations currently used by other sciences. He will discuss potential ways to adapt the non-linear differential equations to model an Air Campaign and demonstrate the potential applications of this approach through a prototype simulation to study the military utility of GPS guided munitions.

Wednesday, 1330-1500
Intercontinental Ballistic Missiles as Space Launch Vehicles

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The authors performed a study to assess the cost effectiveness of ICBMs as space launch vehicles. The study concentrated on the Peacekeeper and Minuteman weapon systems as representative ICBMs. For effectiveness, we examined utility (performance and responsiveness) and feasibility (development, logistics, and policy). For cost, we developed estimates for both ICBM systems and compared them to commercially available systems. The study showed both systems offered similar utility to current launch vehicles, were feasible, and offered cost savings.

Cost Effectiveness of Innovative Upper Stage Propulsion and Electrical Power Technologies

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Today upper stage rocket propulsion means chemical propulsion. Within ten years, alternative innovative propulsion technologies could be operational. These innovative propulsion technologies have higher specific impulses than current chemical systems. Higher specific impulse can potentially reduce launch costs by enabling payloads to be launched by smaller, less costly boosters, *or* it can potentially place more payload mass on operational orbit using the same booster. These advantages are

often offset by substantially lower thrust than produced by chemical systems, resulting in lengthened orbital transfer times. We have used a uniform methodology to quantify potential effectiveness and cost-effectiveness advantages of the innovative technologies. Electrical power generation is also considered because many of the innovative technologies provide electrical power that could replace on-orbit satellite photovoltaic power.

Wednesday, 1515 - 1645

A Complete System for the Extraction of Roads from Multispectral Satellite Images

LTC John Marin
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Extracting roads from satellite images is an important problem with applications in both the military and private sectors. Manually extracting roads is a time-consuming and tedious task, requiring numerous man-hours to process an image, and is usually limited to single-dimensional data. This research presents a two-step method for extracting roads in noisy, multispectral, satellite images. In the first step, a neurally inspired classifier, Learning Vector Quantization (LVQ), is employed to initially classify image pixels. The second step describes a process for tracking roads in a binary image, such as the output from the LVQ classification process. The tracking process includes a discussion of a new noise reduction algorithm, and a procedure to link disjoint road segments using a potential-function guided best-first search. This technique allows for the assimilation of supporting information, such as data from a Digital Elevation Model. The system described in this research differs from existing systems in that it is based-on the spectral properties of roads rather than locating edges. Additionally, this research describes a complete road extraction procedure that goes from a satellite image to a traced road.

The Emerging DoD Hyper-Spectral Imagery (HSI) Initiative - A Challenge for Operations Research

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The ever improving availability of low cost data collection, storage, and processing hardware coupled with continued research in automated materials discrimination from remotely-sensed earth imagery has evolved Hyper-Spectral Imaging from obscure laboratory experiments to plans for fielded DoD and commercial sensor systems. The massive data volume characteristic of HSI and its improved availability is likely to continue to outpace the capacity of small tactical systems to store and analyze the imagery in a timely fashion. Clearly, operations research which focuses on intelligent data reduction and process optimization can contribute solutions to this problem. In this paper we present the current status of the DoD HSI initiative, planned collection systems, and how operations research strategies can and are being applied to make HSI a practical tool for solving complex military intelligence problems.

Thursday, 0830-1000

Reusable Spacelift Concepts Study (RSCS)

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The RSCS analyzed the feasibility and cost-effectiveness of various reusable orbital transfer vehicle (ROTV) concepts that utilize innovative technologies such as electric and thermal propulsion. Analysis also compared the cost-effectiveness of ROTVs to spacelift systems with chemical upper stages and non-reusable orbital transfer vehicles that utilize innovative propulsion technologies. Cost-effectiveness results were developed for the current fleet of expendable launch vehicles, enhanced expendable launch vehicles (EELV), and reusable launch vehicles (RLV).

Assessing the Impact of Reusable Orbital Transfer Vehicles for Spacelift Modernization

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The Satellite Reusable Orbital Transfer Vehicles (ROTVs) simulation model is part of a multi-organization Reusable Spacelift Concepts Study (RSCS) that assesses and identifies the most cost effective solutions for near and mid term AFSPACECOM spacelift deficiencies. Satellite ROTVs are integral for transferring satellites from their initial orbit after launch to the satellites' mission orbit. A simulation model was developed to determine the number ROTVs required to successfully perform their mission based on different ROTV propulsion technologies. The model takes the input parameters of each ROTV technology and the determines the optimum number of ROTVs based on several performance criteria. The major performance measures were satellite waiting time in the initial orbit, ROTV utilization, and ROTV deployment time. Powerful features of the model include sensitivity analysis on ROTV parameters, as well as analyzing the performance measures of satellites in different mission orbits.

WG 18 — OPERATIONS RESEARCH AND INTELLIGENCE — Agenda

Chair: Peter A. Shugart, USA TRAC

Co-chair: Dr. Allan Rehm, MITRE

Room: GIF, 354-B

Tuesday, 1030 - 1200

ARCENT Support: Threat Deployment Risk Analysis & Course of Action Assessment

LTC Wm Forrest Crain, U. S. Army Concepts Analysis Agency

Measuring Intelligence On The Battlefield

MAJ Michael L Boller and Mr. Richard Cunninham, TRAC-FLVN

Tuesday, 1530 - 1700

Political And Economic Risk In Countries And Lands Evaluation Study (Pericles)

Mr. J. Theodore Ahrens, U. S. Army Concepts Analysis Agency

The Bear Went Over the Mountain: Soviet Combat Tactics In Afghanistan

Mr. Lester Grau, USA FMSO

Wednesday, 0830 - 1000

Practical Assignments of Multi-Criteria Missions Over Multiple Time Periods Using a Russian Method Modified to Utilize Genetic Algorithms.

Ms. Barbara Dixon and Mr. David Dixon, USA TRAC

Effects of Simulating Crew Coordination in Russian Armored Fighting Vehicles

Mr. Kevin Young and Mr. Pete Shugart, USA TRAC

Wednesday, 1330 - 1500

A New Weapon in the Information War: Subjective Probability as a Decision Aid

Maj. David H. Olwell, Department Of Mathematical Sciences, US Military Academy

Information Warfare and Deterrence

Joseph J. Helman, TASC

Wednesday, 1515 - 1645

Representing Information Warfare In a Corps-Level Combat Model

LTC Robert S. Alexander, U. S. Army Concepts Analysis Agency

Intelligence, Surveillance and Reconnaissance Simulator (ISRSIM) -- An Overview

Mr. Jeff Knox, SAIC

Thursday, 0830 - 1000

Sensor Accuracy and Latency Versus the Probability of Target Detection and Aircraft Attrition

Richard Tepel, Teledyne Brown Engineering and RuthAnne Dorman, System Simulation Solutions, Inc.

C4ISR Modeling, Simulation and Analysis in Support of Real Time Retargeting (RTR)

Robert Sheldon, SAIC

Country Infrastructure Network Model: Examples and Demonstration

Dr. Allan Rehm and J. Scott Martinm, MITRE Corporation

Thursday, 1330 - 1500

COMPOSITE GROUP IV SESSION .... GIF, Dupuy Auditorium

Tuesday, 1030 - 1200

ARCENT Support: Threat Deployment Risk Analysis & Course of Action Assessment

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ARCENT Support provides the results of two analytic efforts which have enhanced the intelligence and operational capabilities of the U.S. Army Central Command (ARCENT). The threat deployment and risk assessment utilizes a linear programming (LP) algorithm to simulate an optimized mobilization and deployment for a given force. The analysis considers current t transportation networks, the available transportation assets, and the forces to be moved, and identifies sequences and timelines of specific units which minimize the time to complete the deployment. The results of the analysis closely predicted the mobilization and deployment of the Iraqi Army in Oct. 94.

The course of action assessment employs a decision tree or dendritic model to systematically merge friendly and enemy courses of action. Such an integration permits a robust identification of branches and sequels, highlights potential operational risks, and facilitates the identification of priority intelligence requirements for the allocation of intelligence gathering assets.

Measuring Intelligence On The Battlefield

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This methodology presented here was developed during the conduct of the Unmanned Aerial Vehicle Study. In analyzing data generated by combat simulations, it became clear that measures of effectiveness derived from the killer-victim scoreboard did not discriminate between the different intelligence gathering systems. The newly perfected methodology measures the difference between the perceived intelligence picture of one of the sides --taking into account sensor accuracy and timeliness-- and ground truth. Hourly results were tabulated into one of five categories, and a weighting algorithm was used to derive an overall rating. This method also gives a quick, accurate overviews of the intelligence situation.

Tuesday, 1530 - 1700

Political And Economic Risk In Countries And Lands Evaluation Study (Pericles)

Mr. J. Theodore Ahrens
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PERICLES developed and demonstrated an analytical methodology that incorporates quantifiable measures of the political economic, environmental/infrastructure, social/cultural, and military risk associated with foreign nations as a part of the Army s overall threat assessment. This study, conducted for the Office of the Deputy Chief of Staff for Intelligence, evaluated historical data on 19 factors that when integrated would be used to identify areas of potential instability for 200 countries. A graphical interface tool was also developed and demonstrated to display the results and allow for user interaction. The basis for this study arose from the growing need in the defense and security community to synthesize and analyze information regarding the causes of conflict in addition to military factors.

The Bear Went Over the Mountain: Soviet Combat Tactics In Afghanistan

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Soviet ground forces tactics were designed for high-speed mechanized warfare on the rolling plains of Europe and China. The implementation details of these tactics (e.g. norms for fire, march procedures, reconnaissance requirements, etc.) were derived from a mathematical basis. These Cold War era tactics did not work in the harsh terrain of Afghanistan against the highly-motivated Mujahideen resistance fighters, and the Soviets developed new tactics during the course of their lengthy war. To capture the lessons their tactical leaders learned, and to explain the subsequent change in tactics, the Frunze Military Academy complied a book of tactical examples, without providing the underlying rationale. Examples from this book will be presented not only to introduce them as an alternate to more conventional combat, but also to stimulate discussion as to whether or not their detail continues the tradition of quantitative derivation, and if so, is it an implementation of the current theory with new parameters, or a new theoretic basis.

Wednesday, 0830 - 1000

Practical Assignments of Multi-Criteria Missions Over Multiple Time Periods Using a Russian Method Modified to Utilize Genetic Algorithms.

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A class of resource allocation problems deal with the allocation of groups of resources to groups of tasks. Problems of this type can often be formulated as binary programming problems with multiple optimization criteria. Podinavski and Gavrilov developed an algorithm for solving such problems which was used by the Soviet army to determine optimal assignments of artillery forces to targets.

This paper presents a discussion, with examples, of the original algorithm -- emphasizing a description of the method of reduction of the multi-criteria problem to a single objective, an extension of the algorithm to deal with optimal allocation over multiple time periods, and the replacement of an exhaustive search with a genetic algorithm.

Effects of Simulating Crew Coordination in Russian Armored Fighting Vehicles

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The purpose of this project was to investigate a means of modeling Soviet style armored fighting vehicle crew coordination with more detail than currently done. The coordination simulated includes search techniques of the commander and gunner, the designation of the target by the commander, and the munitions selection criteria.

The more detailed representation of enemy crew coordination resulted in additional detection of friendly forces, an increase in the number of shots fired at friendly forces, longer ranges for enemy ATGM engagements, and a decrease in enemy attrition.

Wednesday, 1330 - 1500

A New Weapon in the Information War: Subjective Probability as a Decision Aid

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This paper outlines the application of a new statistical technique to tactical decision making. We transform into a linear program the problem of choosing between friendly courses of action given uncertain enemy conditions and intentions. This approach follows fundamental work done by the Italian probabilist Bruno Di Finetti. The method integrates the results of wargaming, expert staff opinion, and reports from collection activities to produce strict probability limits on the chances of success of friendly courses of action. These limits assist the commander in making decisions.

Sensitivity analysis of the linear program gives useful information for setting and prioritizing intelligence collection activities. Varying the inputs allows the commander to ask and answer informative What if? questions. We propose and demonstrate a friendly graphical user interface.

Information Warfare and Deterrence

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The information revolution and associated technical innovations are adding new dimensions to international conflict. Traditional methods of warfare are being supplemented by technology-based warfare, including what has become known as Information Warfare (IW). IW can involve electronic attacks to disable or disrupt systems (e.g., malicious code), attacks aimed at undermining the reliability of data in a system, or denial of service attacks (e.g., magnetic bombs). Thus, launching an attack upon an adversary s vital national resources is no longer limited to the use of military forces. Substantial and potentially devastating harm can be inflicted without crossing the threshold of violence or even physically crossing international borders.

The research questions addressed in this study include: Can the threat of retaliation against the information infrastructure of an adversary be adequate to deter an attack upon the U.S. National Information Infrastructure (NII)? How is retaliatory credibility established? When should a threat be communicated? Given the inherent speed of an IW attack, can stability be achieved to ensure that neither side erroneously launches an attack? This paper attempts to answer these questions and advance our understanding of warfare in the information age by developing relevant concepts and a systematic framework for analysis.

Wednesday, 1515 - 1645

Representing Information Warfare In a Corps-Level Combat Model

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The representation of information warfare in constructive models is not fully developed, especially in aggregated models. At the Operational level of combat, this deficiency is being addressed at the United States Army Concepts Analysis Agency using the combat simulation, EAGLE. The effects, of digital sensor-to-shooter links, intelligence fusion, command and control technology (specifically the Army Tactical Command and Control System [ATCCS]), and digitization of the battlefield were all modeled in EAGLE scenarios used to support the biennial capital budgeting study Value Added Analysis . In this presentation, the schemes for representing these various information warfare functions are discussed. This first use of Eagle in a major analytical effort demonstrated that EAGLE promises to be a useful tool for understanding the future of combat operations in the context of Force XXI initiatives and issues.

Intelligence, Surveillance and Reconnaissance Simulator (ISRSIM) -- An Overview

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The Intelligence, Surveillance and Reconnaissance Simulator (ISRSIM) is a computer based simulator which has been developed with the purpose of analyzing the performance of ISR systems, and the availability, timeliness and quality of information to the warfighter. ISRSIM models collections systems for SIGINT, IMINT, IR, LADAR, RADAR and HIMINT disciplines as well as the emission characteristics (signatures and time schedules) of target sets. The time-lines and resource utilization required to process, exploit and disseminate the collected information are modeled using a flexible rule-based approach. The model is currently installed at government and contractor sites for supporting ISR system analysis requirements of OSD, JCS, Army, Air Force, Navy, and classified customers.

Thursday, 0830 - 1000

Sensor Accuracy and Latency Versus the Probability of Target Detection and Aircraft Attrition

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Approved abstract not available at printing.

C4ISR Modeling, Simulation and Analysis in Support of Real Time Retargeting (RTR)

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The Office of Naval Research (ONR) is sponsoring an Accelerated Capability Initiative (ACI) to demonstrate the feasibility of improved C4ISR in conjunction with RTR, and its impact on warfighter capabilities. The objective of the RTR ACI is to improve cruise missile and TACAIR capabilities for timely prosecution of strike targets in a dynamic environment. RTR requires integrated surveillance, target acquisition and processing with precision weapons for rapid response against high-value, short dwell targets. This paper focuses on the concept of operations and architecture defining C4ISR connectivity needed to implement RTR. A modeling and simulation construct developed using the Judy C4ISR model is used to analyze the problem. Specific RTR technology initiatives, such as automatic target recognition and optimal route planning, are analyzed in an MRC campaign.

Country Infrastructure Network Model: Examples and Demonstration

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The Country Infrastructure Network (CIN) model prototype was developed for the Joint Warfighting Center (JWFC), Ft. Monroe, VA to assist wargame control teams with the assessment of the implications of damage to targets that have the structure of flow networks, namely, oil and gas pipeline systems, water pipelines, and electric power networks to a first approximation.

The system uses COTS software and standard OR algorithms to model network flow. The MapInfo GIS is used to display graphically the nodes, arcs, capacities and flows both on a map of the region and as a schematic diagram to provide more insights into the structure of the network incurring damage. Nodes and arcs can be removed (or added) and the program recalculates the flows to show the effects of damage.

Some examples of historical interest are modeled using open source data to demonstrate some of the potential uses for wargame control teams, wargame players, intelligence analysis and collection planning, testing war plans, operational planning, and civil defense planning to counter the effects of the destruction of friendly networks.

WG 19 — MEASURES OF EFFECTIVENESS — Agenda

Chair: Robert J. Meyer, NAWC-WPNS
Cochair: Maj James E. Herring, AFSAA/SAG
Advisor: John M. Green, Lockheed Martin
Room: GIF, 359-C

Tuesday, 1030-1200
Integrated Warfare Modeling
Harold W. George, Northrop Grumman Corporation

A Comparison of Theater Ballistic Missile Defense (TBMD) Coverage Measures
Walter Stumpf, Systems Planning and Analysis, Inc.

Tuesday, 1530-1700
Survivability Analysis to Support Operational Evaluation
J. Bryan Lail, NAWC-WPNS, China Lake

JETTA -- Is DIS Ready For The Analyst?
Michael Gray & George T. Cherolis, BDM Engineering Services Company

Wednesday, 0830-1000
Electronic Combat Requirements Development
Major James E. Herring, Air Force Studies & Analysis Agency

Wednesday, 1330-1500
MOEs in Electronic Combat: How the Warfighter Spells Military Worth
Robert J. Meyer, NAWC-WPNS, China Lake

Recent Technological Advances in Measures of Effectiveness of Combat Forces
Dr Robert L. Helmbold, U.S. Army Concepts Analysis Agency

Wednesday, 1515 - 1645
TBD

Thursday, 0830-1000
COMPOSITE GROUP V SESSION .... **GIF, Dupuy Auditorium**

Thursday, 1330-1500
TBD

WG 19 - MEASURES OF EFFECTIVENESS - Abstracts

Tuesday, 1030-1200
Integrated Warfare Modeling

Harold W. George, Manager, Integrated Warfare Analysis
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Iraq demonstrated the political impact and potential military utility of tactical ballistic missiles during Desert Storm. The growing world-wide proliferation of ballistic and cruise missiles, and the likely improvements associated with future weapon systems, pose a significant problem to the military planner.

Air defense architectures consisting of sensors, shooters, weapons, communication links, and concepts of operations need to be developed to counter the theater missile threat to U.S. forces and their allies. Existing DoD sponsored computer models do not adequately represent all of the elements of such an air defense architecture. These models have traditionally emphasized anti-air warfare and strike operations over surveillance, battle management and electronic warfare.

This paper describes an Independent Research and Development (IRAD) activity to develop an Integrated Warfare Model for evaluating warfare architectures in realistic mission environments using a "system of systems" approach. The resulting methodology combines internally developed warfare models with standard DoD mission and theater-level models. The paper illustrates the application of the methodology to Theater

Missile Defense studies, and identifies the MOEs required at each stage of the analysis.

A Comparison of Theater Ballistic Missile Defense (TBMD) Coverage Measures

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Approved abstract not available at printing.

<u>Tuesday, 1530-1700</u>
Survivability Analysis to Support Operational Evaluation

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Approved abstract not available at printing.

JETTA -- Is DIS Ready For The Analyst?

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The Joint Environment for Testing, Training and Analysis (JETTA) project was sponsored by the Defense Modeling and Simulation Office to establish a simulation and data collection network, architecture and tool set capable of linking live, virtual and constructive simulations in a Joint virtual battle space. The JETTA distributed simulation network included:

- the Naval Command, Control, and Ocean Surveillance Center RDT&E Division;
- the JTIDS System Integration Facility;
- the Naval Air Warfare Center, Weapons Division Battle Management Interoperability Center and Weapons Tactics and Analysis Center;
- the National Test Facility;
- the Tactical Air Command and Control Simulation Facility (TACCSF);
- the Theater Battle Arena;
- The Depth and Simultaneous Attack Battle Lab;
- and Boeing Space and Defense Division.

The JETTA program was successful in integrating Joint distributed simulations and real systems using DIS protocols and in providing an effective simulation of the Joint Warfare environment. This presentation covers the current state of the JETTA network to provide accurate and timely data collection on critical events to facilitate analysis of performance and effectiveness of Joint operational concepts or systems. Both network and operational performance measures are addressed from the perspective of an air warfare analyst.

<u>Wednesday, 0830-1000</u>
Electronic Combat Requirements Development

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The Air Force Studies and Analyses Agency has developed an innovative process to develop and relate the Electronic Combat requirements of the "warfighter." While the B-1B Defensive System Upgrade Program is the first application, requirements development for other programs can also benefit from the three-phase process described in this paper:

I. Concept of Operation (CONOPS) We first had the joint force combat commander, using an approved threat scenario, identify theater military objectives and theater air objectives and establish an acceptable attrition level. We next took these inputs to the Joint Forces Air Component Commander's staff and had them allocate aircraft, weapons, and electronic combat assets to produce air tasking orders (ATO's) for execution of the air campaign. Finally, we had aircrews from the joint force aircraft at Nellis AFB plan missions executing these ATO's, and then had Air Force Weapons School instructors check the mission planning for tactical validity.

II. Modeling & Simulation (M&S). We used M&S was to quantify the warfighter requirement to destroy enemy targets by using the mission plans developed at Nellis in a mission level model, finding that some missions could be completed without electronic countermeasures (ECM), while many could not. We increased the effectiveness of ECM until the missions could be completed without exceeding the maximum allowable attrition rate, thereby resulting in ECM requirements scaled between the dry case and benchmark measures of off-the-shelf technology.

III. Communication of Results. Requirements and measures identified by this process are being communicated in an Operational Requirements Document (ORD), tracked through the acquisition process and realistically evaluated during test and evaluation. When successfully completed it will provide the first traceable approach for EC acquisition programs.

<u>Wednesday, 1330-1500</u>
MOEs in Electronic Combat: How the Warfighter Spells Military Worth

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One of the raging debates within DoD over the last ten (or more) years is how to (best) measure the "military worth" or contribution to warfighting ability of Electronic Warfare (EW) in general and Electronic Counter Measures (ECM) in particular. Previous work suggested that rather than using the fuzzy concept of "military worth," EW/ECM utility may be best be measured in more concrete terms familiar or at least understandable to the operational units which are expected to employ that EW/ECM. One of the ways previously suggested to portray ECM utility was to couch it in terms of single-ship survival, and how one could

trade-off ECM benefits with those provided by stealth, tactics, maneuverability, situational awareness, vulnerability reduction, etc., in the context of platform survivability.

The replacement of the term "military worth" with more concrete measures is not arbitrarily limited to engagement-level issues such as platform survivability, but has logical extensions to all levels of combat. This presentation explores such concrete measures not only at the engagement level, but upwards through "mission level" to "force level" and beyond, showing that at each level such measures exist but are best understood in the very unique and non-linear (subjective) contexts associated with those levels. Further, this presentation argues that any pseudo-mathematical cascading of these measures into some overall notion of "military worth" misses the mark badly, and that only contextual assimilation of these measures allows their full embodiment in both requirements development and subsequent test and evaluation.

Recent Technological Advances in Measures of Effectiveness of Combat Forces

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All of the Measures of Effectiveness (MOEs) that have heretofore been proposed for combat operations deal with limited aspects of military operations. Such MOEs inevitably lead to suboptimal decisions or to optimizations that are, at best, only partial contributions to the overall effectiveness of a military combat organization. In addition, none of the currently used MOEs provide a measure that has been demonstrated to be closely related to combat effectiveness.

Recent developments have discovered a MOE that overcomes these shortcomings. This presentation will define this MOE and present historical data confirming its applicability to measuring the degree to which combat forces are able to dominate the battlefield.

Wednesday, 1515 - 1645
TBD

Thursday, 0830-1000
COMPOSITE GROUP V SESSION
GIF, Dupuy Auditorium

Thursday, 1330-1500
TBD

WG 20 — TEST and EVALUATION — Agenda

Chair: Michelle Kirstein, HQ AFOTEC
Co-chair(s): Wink Yelverton, SENTEL Corporation
Blair Budai, Edwards AFB
Gene Dutoit, Army Dismounted Battlespace Lab
Bard K. Mansager, NPS
Dr. Ernie Montagne, BDM
LT Cynthia Womble, COMOPTEVFOR
Advisor: Dr. Marion Williams, FS, AFOTEC/CN
Room: GIF, 254-A&C

Tuesday, 1030-1200
The Test Engineer's Workstation
Brian Keeton and Richard Morrison, Georgia Tech Research Institute

V/L Modeling in Support of Test and Evaluation
Lisa K. Roach, AMSRL-SL-BA, Aberdeen Proving Ground

An Intelligent Hierarchical Analysis Structure for Operational Test and Evaluation
Maj. Suzanne M. Beers, AFOTEC and Dr. George J. Vachtsevanos, Georgia Institute of Technology

Tuesday, 1330-1500
Nonparametric Jammer Flight Testing Using the TrueStat Statistical Software Package
Wesley D. True, Jr., 513th Engineering and Test Squadron\EENA

Combining Developmental and Operational Testing - A Planning Primer
Using Modeling to Support Test Design - Are we being smart in the way we ask the question?
William Moore and Anthony F. Zimmermann, IEWTD/TEXCOM

Testing Software-Intensive Systems: T&E Struggles for Answer
Steven K. Whitehead, Operational Test and Evaluation Force (OPTEVFOR)

Tuesday, 1530-1700
Calibrated Infrared/UV/Visible Ground Air Radiometric Spectrometer (CIGARS)
Shawn M. Goodrich, 46 TW/TSWI

"The Mission Level Assessment Tool (MLAT): Integration of Flight Test, Digital and Hybrid Simulations for Operational Assessment"
Capt. Kurt Rinke, HQ AFOTEC DET, 31 TES 1; Dr. Dave Culp, CALSPAN Corporation; M. Walter March, SAIC

VV&A of Synthetic Environments: Proposed Definitions
Dr. R. J. R. Miller, Centre for Defence Analysis; Dr. Patrick D. Allen, Cubic Applications, Inc.

Wednesday, 0830-1000
Infrared Interactive Facility (IRIF)
Charles T. Churillo, TYBRIN Corporation

Mission Analysis and Reporting System (MARS) - EW Analysis and Reporting on a Personal Computer
Ken Burton, TYBRIN Corporation

Desktop GPS Analyst - GPS Data Processing and Analysis on a Personal Computer
Dennis L. Hart, TYBRIN Corporation

Wednesday, 1330-1500
Digitally-Recorded Data Reduction on a PC Using CAPS
Mike Rarick and Ben-z Lawrence, 96 Communications Group/TYBRIN Corporation

Rapid Availability Prototyping for Testing Operational Readiness (RAPTOR)
Capt. Jeffrey Jacobs, Capt. Charles M. Carter and Mr. Kenneth E. Murphy, HQ AFOTEC/SAL

Use of Fractional Factorial Experiments and Simulations in Order to Streamline Testing
Eugene F. Dutoit, Dismounted Battlespace Battle Lab

Wednesday, 1515 - 1645
Automated Evaluation of Tactical Radio Protocols
Maria C. Lopez, Ann E. M. Brodeen, George W. Hartwig, Jr., and Mike J. Markowski, U.S. Army Research Laboratory

Advanced Concept Technology Demonstrations (ACTDs)
Maj. Edward C. Mitchell, AFOTEC

Can Operational Testing be on a Not-to-Interfere Basis?
Lt. Cynthia M. Womble, Operational Test and Evaluation Force (OPTEVFOR)

Thursday, 0830-1000
COMPOSITE GROUP V .... **GIF, Dupuy Auditorium**

Thursday, 1330-1500
"Did You See What I Saw?"
Dr. Hank Dubin, U.S. Army Operational Test and Evaluation Command and George Chernowitz, American Power Jet Company

A Physics-of-Failure Approach to Accelerated Life Testing of Electronic Equipment
Thomas J. Stadterman, William F. Braerman, and Barry Hum, U.S. Army Material Systems Analysis Activity

Automated Data Collection, Reduction, and Analysis Methodology (ADCRAM) for Information System Operational Test and Evaluation (OT&E) -- The Air Mobility Command (AMC) C^2 Information Processing System (C^2IPS) Model for Theater Battle Management (TBM)
Nickolas P. Angelo, HQ AFOTEC/TKT

WG 20 — TEST and EVALUATION — Abstracts

Tuesday, 1030 - 1200
The Test Engineer's Workstation

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Testing today's complex EW systems requires elaborate test procedures, and data reduction and analysis processes. Manual test planning and data reduction techniques are quite often too slow and error prone to keep pace with the demands of current test programs. Computer-aided test planning and automated data reduction and analysis software are necessary to obtain timely and accurate test results when evaluating modern EW systems.

The Test Engineer's Workstation provides a platform for test engineers to develop test plans, execute data reduction and analysis software for processing EW test data and, through multimedia presentations, learn the techniques for planning and executing a successful test program in accordance with the EC test process. The Automated Data Reduction Software (ADRS) of the Workstation has been used in various test facilities including laboratory, hardware-in-the-loop, installed system, and open-air test ranges to evaluate Radar Warning Receivers, Missile Warning Receivers, and Self-Protection Jammers. Due to its broad application and standardized measures of performance outputs, ADRS is a useful tool to assist test engineers in analyzing test data, generating final test reports, and correlating test results from different facilities and test phases. Due to its fast execution speed, ADRS can be connected to test data acquisition and environment quality assurance instrumentation to provide real-time test results to the test engineer. Through the use of graphics displays, and a Microsoft Windows user interface, system-under-test anomalies can be quickly identified and analyzed. System measure of performance outputs from ADRS allow comparison of test data to (1) other EW systems or other versions of the same system (e.g., baseline versus upgrade), (2) results generated at other test facilities, or (3) modeling and simulation outputs. The Workstation additionally provides multimedia functionality to train new test engineers in the procedures necessary to plan, execute, and analyze a test. This training material can easily be expanded and tailored to specific test facilities.

V/L Modeling in Support of Test and Evaluation

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For the past several years, the Ballistic Vulnerability/Lethality Division (BVLD) of the U.S. Army Research Laboratory's Survivability/Lethality Analysis Directorate (ARL/SLAD) has been developing new approaches and methodologies to define and generate vulnerability/lethality (V/L) metrics that are observable and/or measurable and thus comparable

with live fire test events or experimentation outcomes. The BVLD developed a taxonomy which describes the mathematical framework for all V/L analyses and demonstrated how each part of a well-known process fits into this framework. Further, the Degraded States Vulnerability Methodology (DSVM) was developed and shown to provide an important example of the rigor with which one part of a vulnerability analysis may be conducted, specifically, the formulation of remaining target capability measures resulting from component and subsystem damage. Recently, the DSVM was used to generate preshot predictions for the AH-64D Modernized Apache live fire tests.

This paper will briefly discuss the general V/L taxonomy and the DSVM, highlighting the DSVM's applicability throughout the life cycle of a military system and its link to other aspects of the life cycle such as battle damage repair. The overall context of this paper will show how the modeling efforts of the BVLD have matured to better support the test and evaluation process, using the AH-64D efforts as an example.

An Intelligent Hierarchical Analysis Structure for Operational Test and Evaluation

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Decision-makers who are charged with determining if a system should be procurred for an organization typically depend on information gathered during the Operational Test and Evaluation (OT&E) of the system to help make their acquisition decisions. However, OT&E is typically conducted to provide information on system performance at such a low information-content level, that it is meaningless for the decision-maker. The decision-maker is faced with making a decision on a system's worth based upon reams of information at the system-specification level. How does the decision-maker take this type of low-level information and turn it into information which is relevant to the decision he is trying to make? An ***Intelligent Hierarchical Analysis Structure (IHAS)*** has been developed, using fuzzy logic and neural network concepts, through which low-level test data can be aggregated and synthesized to provide information to the decision-maker at the task-accomplishment level. With information on how well a system performs a task, based upon measurements of technical system performance in the laboratory or test range, the decision-maker's job is substantially easier. The IHAS takes as input, test data, preprocessed such that it is a measurement of the system-under-test's performance at a functional or technical performance level. The ***Clustering Methodology*** takes the measurements of functional performance and generates a Composite Fuzzy Membership Function (COMMFFY). The COMMFFY is a fuzzy distribution of the original test data based upon the test observations and pre-defined Basic Membership Functions. Within the Clustering Method, an optimization of made of the available compositional techniques, such that the output of the clustering phase is optimal for a given test data set. The output of the Clustering Methodology is a COMMFFY, still at the system's functional performance level. The next phase of the IHAS, the ***Fuzzy Associative Memory***, serves to make the transition from the functional performance level to the task accomplishment level. The FAM within the IHAS is similar to Fuzzy Associative Memories described in the fuzzy literature except that it has been modified to handle fuzzy distributions (in the form of a COMMFFY) rather than individual data points. Once the FAM has transformed the information gathered at the system functional performance level to the task accomplishment level, the ***Fuzzy Cognitive Map*** adjusts the COMMFFY to take into consideration factors which could not be included or controlled during testing. Finally, all the logical breakouts of the system performance are aggregated together in the final ***Aggregation Methodology*** phase of the IHAS. In this aggregation, both a minimum and maximum fuzzy operation are used such that the final result is an upper and lower bound on the system performance.

Tuesday, 1330 - 1500

Nonparametric Jammer Flight Testing Using the TrueStat Statistical Software Package

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Testing jammers aboard aircraft while in flight is very expensive. Since budgets are not unlimited, sample sizes are usually very small. Since the distribution of the data is unknown and the sample sizes are small, nonparametric statistics are desired.

To test the performance of the jammers two types of aircraft positions are recorded. The actual position of the aircraft and the perceived position of the aircraft from threat simulators. The difference between these two positions is tracking errors.

The data is then categorized and tested for differences. An example of two types of categories could be when the jammer was off and when the jammer was on. The difference between these two categories would be the ability of your jammer. We have created a software package called TrueStat that uses two sets of data and calculates parametric and nonparametric statistics.

TrueStat is an extremely user friendly windows driven statistical package written in Foxpro and C++. It compares two samples of any size and three confidence levels using the Student's t-test and the Mann-Whitney test statistic. It also calculates basic statistics and performs a Lilliefor's test for normality. Along with these results it also calculates a p-value.

The package is supplied on two 3.5 diskettes and is a stand alone program that can be used on a minimum of a 386 with a 640X480 resolution screen and 8Mb of memory for windows and 2Mb for the program.

Future modifications will include a help file, improved processing speed, and accommodate binomial data.

Combining Developmental and Operational Testing - A Planning Primer

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One potential method for reducing the expense and complexity of testing is to combine both developmental (DT) and operational testing (OT). While this is a simple idea, examples of the idea being implemented seem to be few. The Intelligence and Electronic Warfare Test Directorate (IEWTD) of the US Army Test and Experimental Command (TEXCOM) has an opportunity to implement this idea during the testing of the Airborne Standoff Minefield Detection System (ASTAMIDS). This system is in the very early stages of the acquisition process and should lend itself easily to combining the DT, done by the US Army Electronic Proving Ground (EPG) and the OT, done by IEWTD. During the planning for this test, scheduled for 1996 at Fort Huachuca, Arizona, both organizations worked together to plan and conduct a truly combined test(CT). This test used common databases for both effectiveness and suitablility, including Reliability, Availability and Maintainability (RAM). Additionally, a common master events list (MEL), instrumentation and facilities were used to gain further efficiencies. The result should be a test which supports the decision to progress in the acquisition process at a cost substantially below what two separate tests would have cost.

Using modeling to support test design-Are we being smart in the way we ask the question?

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Smart modeling leads to smart decisions. This paper explores our efforts to design a combined operational and developmental test despite flight safety constraints. The "business as usual" approach to the test design resulted in denying 50% of the available time for data collection and prohibited collection for one of the PM's critical issues. By using a model and data from some very early technical testing, we were able to support a rationale for redefining some of the parameters. That redefinition resulted in a test design which would in fact support the PM's critical requirements. That redefinition also resulted in a significant reduction in the number of trial runs required, hence money saved!

Testing Software-intensive Systems: T& E Struggles for Answers

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For operational testers, software raises a lot of troubling questions. Years ago, software-intensive systems were largely mainframe based and operational testing was conducted with a parochial view that, as independent testers, the only way to ensure the fleet received the best product was to test strictly from the perspective of the fleet operator. As software grew more complex, "whole system" testing became increasingly unwieldly and time consuming. Methods for operational testing software-intensive systems have changed little and today's software testing strategies are still fundamentally rooted in a hardware mentality. At the same time, the fleet continues to demand newer technology and better software. Obviously, an unresponsive acquisition process reduces readiness, but sending untested systems to sea reduces readiness even more.

Clearly a more innovative approach to testing software is required, one which balances the requirements for fast and economic acquisition with the demand for quality products. OPTEVFOR recently conducted an in-depth study of how the Navy acquires, develops, and tests software-intensive systems. The results of the study was the development of an initial procedure for reviewing the software development process. OPTEVFOR has added a software development annex to all test plans that apply to software-intensive systems. The results of the assessments are provided solely to the program managers, they aid in the formation of a software development confidence measure, providing the program manager with a valuable tool by which to measure the developer's quality.

Tuesday, 1530 - 1700

Calibrated Infrared/UV/Visible Ground Air Radiometric Spectrometer (CIGARS)

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The CIGARS systems are high spectral scan rate/medium resolution multi-platform Fourier Transform Spectrometers. The systems provide a versatile capability to collect dynamic spectral signature data of missiles, countermeasures, aircraft and a wide variety of other aerial and surface targets. CIGARS covers the Ultra-Violet (0.2 microns) to the Long Wave Infrared (12.0 microns) with four detector module kits. Scan rates/resolutions vary from 100 spectra/second at 6 wave number resolution to 10 spectra/second at 0.3 wavenumber resolution. CIGARS is currently operational on the F-15 in the Beam Approach Seeker Evaluation System (BASES) pod, on the Airborne Seeker Evaluation Test System (ASETS) a 46TW C-130, in stand alone on a Kinetic Tracking Mount (KTM), and other ground mount configurations.

The CIGARS systems, though new, have collected a large quantity of data on aircraft, missiles, bombs and explosions. Joint and Multi-service testing includes such programs as the Joint Tactical Missiles Signatures (JTAMS) program, Chicken Little, Sensor Fused Weapon and Dipole Pride. Unclassified data products will be presented.

The Mission Level Assessment Tool (MLAT): Integration of Flight Test, Digital and Hybrid Simulations for Operational Assessment

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The Mission Level Assessment Tool (MLAT) encompasses digital modeling, hybrid modeling, and flight test data to assess aircraft survivability. The MLAT process was developed based on the Electronic Combat (EC) Test Process Guide (AF Pamphlet 58-5). The EC process requires, prior to flight test, use of digital and hybrid simulations to determine critical measures of performance (CMOP) which greatly affect susceptibility. CMOPs allow us to maximize data collection by focusing flight test objectives toward those factors that greatly enhance or decrease susceptibility. These CMOPs can then be investigated with digital modeling and hybrid simulations. Based on this analytical process, flight test is used to answer specific measures of effectiveness (MOE). MLAT methodology transcends the initial pre-test planning responsibility of digital and hybrid modeling. With it's reliance on flight test to calibrate the simulations, the MLAT process provides an operationally realistic procedure to perform the analysis necessary to answer the additional measures of effectiveness in the guiding test documents.

The digital modeling leg of the MLAT is a group of simulations that run under the ACES/PHOENIX architecture. These simulations include AASPEM, ALARM, ESAMS, RADGUNS, FPG, and a few passive detection models. ALARM and the passive detection models answer the susceptibility question for ground based systems. AASPEM, ESAMS, and RADGUNS handle the engagement aspects of the analysis, to include both susceptibility and lethality considerations, for air-to-air, surface-to-air, and anti-aircraft artillery, respectively. The Real-Time Electromagnetic Digitally Controlled Analyzer Processor (REDCAP) provides the hybrid modeling support for the MLAT process. This manned simulation specializes in the C3 function which includes assimilating tracks, committing protection assets (SAMs, AI's, etc.), and controlling GCI intercepts.

The Mission Level Assessment Tool (MLAT) is depicted in Figure 1. The ability to answer measures of effectiveness based on a nominal scenario (such as Iraq) is beyond the scope of flight test; the integration of hybrid and digital simulations provides a synergistic analytical environment to accomplish this effort. While this process was developed to assist HQ AFOTEC in providing useful information to the end user on susceptibility, the robustness of the MLAT methodology is also applicable to test programs that require survivability answers.

MLAT makes use of the analytical triad (flight test, digital models, and hybrid models) to meet two goals. First, analysis can be performed on threat systems not available during flight test due to time, resource, or funding constraints. This analysis concentrates on generating susceptibility information similar to that obtained from flight testing (i.e. GCI/AI vectoring and S/I versus Time). The next goal moves beyond susceptibility analysis and focuses on lethality analysis. The lethality analysis still relies on empirical data to calibrate the simulations, and an iterative process is used to modify the models where necessary. The combination of the operationally realistic susceptibility and lethality analysis provides the means to perform a comprehensive survivability evaluation.

VV&A of Synthetic Environments: Proposed Definitions

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The Centre for Defence Analysis is addressing the need to perform verification, validation, and accreditation (VV&A) of live-instrumented, virtual, and constructive environments in support of training and analytical applications. The current literature on VV&A does not adequately address: The dependence of verification and accreditation on the validation process; The dependence of VV&A on the specific application, input data, output measures, and assumptions necessary to support the application objectives; The unique aspects of VV&A when different tools (live-instrumented, virtual, and constructive) are used in various applications; Nor the unique aspects of VV&A of combinations of tools in a single application, such as operational test and evaluation. The definitions of VV&A presented in this paper explicitly account for these dependencies and unique aspects. It is hoped that these proposed definitions will benefit the community, and lead to combat models that can actually be validated within the defined parameters.

<u>*Wednesday, 0830 - 1000*</u>
Infrared Interactive Facility (IRIF)

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To meet the growing need for spatial infrared data reduction and mission analysis capabilities, Eglin AFB has established an interactive facility capable of supporting the system design, test, and evaluation of air-to-air, air-to-ground, and ground-to-ground infrared sensors and seekers. This facility is called the Infrared Interactive Facility or IRIF. Eglin's IRIF currently supports the evaluation and reduction of spatial infrared image data collected

by the Beam Approach Seeker Evaluation System (BASES), the Thermal Image Processing System (TIPS), and the Airborne Seeker Evaluation System (ASETS).

The IRIF environment provides access to volumes of collected image data. Rapid review and editing of signature images, detection of positive and/or negative target signatures, image tabulation and analysis, automated calibration image reading, viewing of pixel values in either counts, radiance or temperature, and the generation of three-dimensional and grayscale presentations of signature images can all be accomplished by the user within the IRIF. Extensive software design, development, and implementations incorporating parameter analysis methods have resulted in a highly automated image analysis and data reduction capability.

Mission Analysis and Reporting System (MARS) - EW Analysis and Reporting On A Personal Computer

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In response to the need to analyze and report upon Electronic Warfare (EW) test data results in a comprehensive and uniform manner, the Mission Analysis and Reporting System (MARS) has been developed.

MARS is a government owned PC based Windows application designed for rapid analysis and reporting upon Electronic Warfare (EW) test mission data. MARS currently performs Jammer Effectiveness (Reduction In Lethality, Increase In Survivability, Reduction In Shot, and Reduction In Hit), RWR System performance (Threat ID, Response Time/Ageout, and DF Accuracy), and Tracking Error Statistics. Additionally, MARS produces several graphical outputs including polar plotting, dynamic strip charting, Cumulative Distribution Functions (CDF), and RWR Simulated Scope analysis. Continual development and maintenance of MARS at the Air Force Development Test Center, Eglin Air Force Base, Florida, has provided a proven product used by numerous DT&E and OT&E test projects over the last four years.

Desktop GPS Analyst - GPS Data Processing and Analysis On A Personal Computer

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There has been a proliferation of Global Positioning System (GPS) receivers and receiver manufacturers and a growing number of DoD test programs employing GPS technology because of its ability to provide high accuracy Time-Space-Position-Information (TSPI). The Air Force Development Test Center (AFDTC) 96th Communications Group (96CG/SCW) recognizes this trend and has pursued development of a government owned personal computer based software application for the generation of GPS-based TSPI.

The Desktop GPS Analyst (DGA) software operates in the Microsoft Windows environment. DGA guides the user through a series of software programs that merge airborne and reference receiver GPS data for the generation of TSPI data products. Inertially aided absolute and unaided or aided differentially corrected TSPI solutions can be obtained with this software. The user selects receiver type to account for differences in receivers due to manufacturer and/or measurement availability. This approach permits creation of a standardized set of GPS measurement data that can be processed using a state-of-the-art Square Root Information Filter/Smoother (SRIF/S) a Best Estimate of Trajectory (BET) algorithm. The resulting TSPI solution can be exported to either custom user software or commercial-off-the-shelf (COTS) software in ASCII or binary formats.

<u>*Wednesday, 1330 - 1500*</u>

Digitally-Recorded Data Reduction on a PC Using CAPS

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The Common Airborne Processing System (CAPS) provides a general purpose government owned data reduction capability for the extraction and engineering unit conversion of either IRIG PCM Class I/II or MIL-STD-1553 raw message data. CAPS provides a productive, user-friendly environment to automate engineering unit conversion of digitally recorded data on a cost-efficient platform. Data can be imported from a variety of formats into the CAPS standard file format. A parameter dictionary describing the raw data structure can be created or imported and edited from within CAPS. Output product descriptions are created and edited within CAPS to describe the format of the desired outputs. All of this functionality is performed on a personal computer within the framework of the graphical user interface provided by Microsoft Windows.

Traditionally, telemetry data reduction was tied to a single telemetry platform and data reduction and analysis process. Extensive software rewrites were required as telemetry systems or analysis software were replaced. The process of digitizing, reducing and analyzing data on large computer systems was often lengthy and always costly. Errors were induced by switching between the analog and digital domains. With the advent of airborne digital recorders, data can remain in the digital domain from collection to analysis but software rewrites may still be required. CAPS provides a cost-savings bridge from raw data to reduction and analysis quickly and flexibly on a PC.

Rapid Availability Prototyping for Testing Operational Readiness (RAPTOR)

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Use Of Fractional Factorial Experiments And Simulations In Order To Streamline Testing

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This paper is, in a sense, a tutorial and proposal to consider the use of both fractional factorial experiments and simulations as tools to streamline the testing and evaluation process. The paper will start with a short review of full factorial experiments and point out the large number of cells and observations that are required to conduct these experiments especially if the number of variables of interest is relatively large. The paper will then introduce the concepts of fractional factorial experiments that use smaller sample sizes and point out the underlying assumptions and constraints that have to be considered when employing these designs. An example using data will be given to highlight the discussion. The paper will propose a method to join the methodologies of simulation and fractional factorial experiments in a complementary role in order to streamline the testing and evaluation process. It is hoped that the proposal will stimulate discussion and debate in order to provide incentives for other members of the Working Group to apply the proposed method or some alternative to their own test and evaluation planning.

Wednesday, 1515 - 1645
Automated Evaluation of Tactical Radio Protocols

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Decentralized battlefield command and control requires reliable and timely distribution of information. At present, distribution of digital information is limited by noisy channels inherent to combat net radios and heavy traffic demands, forcing commanders to make decisions from less than optimal information. In the ideal communications network each node would be smart enough to monitor network performance and, when necessary, adapt itself to better accommodate its workload. The adaptive network node would employ a decision algorithm to modify configuration, routing and protocol parameters based on measured network performance and system requirements. Our research addresses control of noise and interference on communication channels and construction of network protocols that will be effective on the modern battlefield. The approach emphasizes use of actual hardware and controlled experimentation to explore alternative protocols. This paper describes a suite of software to automatically collect and evaluate baseline performance data for a prototype communications network and to determine those factors to which the system is most sensitive.

Advanced Concept Technology Demonstrations (ACTDs)

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The ACTD is an integrating effort to assemble and demonstrate a significant, new military capability, based upon maturing advanced technology(s), in a realistic operational environment to clearly establish operational utility and system integrity. The demonstration is jointly sponsored and implemented by the operational user and materiel developmental communities. In most ACTDs the Operational Requirements Document and CONOPs will be developed by the MAJCOM during the demonstration as they get smarter on the system. A successful ACTD will provide an operational capability that can be tailored and replicated or transitioned into the appropriate point in the formal acquisition process. The ACTDs are intended to provide new technology to the warfighter in three to four years instead of ten to twelve years using the formal acquisition process.

The Secretary of Defense has stated that the Operational (OTAs) Test Agencies should get involved with testing ACTDs. The Office of the Deputy Undersecretary of Defense for Advanced Technology has the responsibility for evaluating ACTD candidates, issuing the Approval Memorandum and providing oversight, support and evaluation of on-going ACTDs. The OTAs will join the Sponsor/MAJCOM Team and assist in demonstration planning and execution to provide test expertise, and ensure operational realism. This paper discusses the ACTD process from the point of view of the OTAs.

Can Operational Testing Be on a Not-to-Interfere Basis?

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Testing on a Not-to-Interfere Basis (NIB) appears on the surface to be inconsistent with operational testing (OT). For the U. S. Navy, however, NIB testing has become the norm for many types of systems, in particular command, control, computer, communications, and intelligence (C4I) systems. Operational testing of naval C4I systems must by definition occur at sea, the intended operating environment for the systems. Current operational tempo and funding constraints make it nearly impossible to send a battle group of ships to sea for the sole purpose of conducting operational testing. Thus, testing for many C4I systems is being scheduled NIB to run concurrently with major fleet training exercises or even while a battle group is deployed to hot spots around the world.

NIB testing is working for the OT of some C4I systems bringing with it a host of challenges as well as benefits. Some of these challenges include the impact to the battle group of using systems that have not completed the OT process, how to collect data without interfering with normal ship operations, and how to account for the many uncontrollable variables of NIB testing. The benefits include testing under much more realistic operational conditions including system loading and throughput, environmentals, operator personnel, and logistics support.

NIB testing is here to stay in the U.S. Navy and it not only is feasible for the conduct of operational testing, it is the best option for many C4I systems.

Thursday, 1330 - 1500
Did You See What I Saw?

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Train As We Fight - Test As We Fight compels us to consider testing in the training environment whenever it is practical. In the training environment, many elements of the assessment come from observers who must make judgments of task performance. To be useful for test and evaluation purposes, such judgments must be repeatable and faithfully represent mission performance. Accordingly, an exploratory probe (Rater Agreement Experiment (RAEX) to characterize variability among qualified observers was designed to examine the observer input aspect of mission-oriented testing and was conducted at Ft. Hood in late 1995. Subject-matter experts utilizing data collection instruments designed for the experiment provided independent scores with supporting narratives for a series of training "battles" during RAEX.

The results provide insights as to the viability of the Mission Training Plan (MTP) test observation paradigm. Analyses address the impact of observer background, training environment and techniques for the conduct of observation to reduce observer biases and variances. Application of the results will enhance the effective integration of observer judgments with numerical and range instrumentation measures to ensure a comprehensive, robust evaluation.

A Physics-of-Failure Approach to Accelerated Life Testing of Electronic Equipment

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Accelerated testing of electronic products offers great potential for improvements in reliability testing. Unfortunately, difficulties encountered in accelerated life testing have limited its application & acceptance. These difficulties can be traced, in part, to a lack of information concerning the dominant failure mechanisms & sites from reliability evaluations conducted during product design. Further, quantitative relationships between accelerated test results and field reliability expectations are also presently unavailable.

This paper presents a discussion of the physics-of-failure approach to accelerated life testing of electronic equipment. Accelerated life testing is achieved by testing at stress levels greater than operational levels to reduce the time-to-failure, or life, of the item. An introduction to accelerated life testing is given followed by an introduction to physics of failure. The importance of failure-mechanism models and the separate treatment of failure mechanisms during accelerated life tests is discussed. Steps on how to design, conduct, and evaluate accelerated life tests are provided. This paper also identifies areas of research that are required to increase the usefulness of accelerated life tests for electronic equipment.

Use of physics-of-failure concepts during the design of electronic products can provide validated, engineering models for root-cause failure mechanisms which can be of great benefit during the design & evaluation of accelerated reliability tests. The growing popularity of the physics-of-failure approach to electronics reliability has the potential of improving the effectiveness of accelerated reliability testing.

Automated Data Collection, Reduction, and Analysis Methodology (ADCRAM) for Information System Operational Test and Evaluation (OT&E) -- the Air Mobility Command (AMC) C2 Information Processing System (C2IPS) Model for Theater Battle Management (TBM).

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Citing the AMC C2IPS evaluation as an empirical model, operational test and evaluators should implement an automated data collection, reduction, and analysis methodology (ADCRAM) to operationally test and evaluate automated information system acquisitions. Based a critical operational issue (COI), measure of effectiveness (MOE), and measure of performance (MOP) acquisition decision making framework, the operational test manager define the ADCRAM. Operational testers of information systems collect objective or subjective data, based on those performance thresholds the information system acquisition customer has specified. They specify data requirements, data sources, and data collection/reduction methods to electronically and manually collect and reduce objective and subjective data. Operational testers of information systems perform quantitative objective and quantitative subjective analysis, based on the type of data and on those performance thresholds the information system acquisition customer has specified. They specify analysis requirements, analysis sources, and data correlation/analysis methods to electronically and manually correlate and analyze objective and subjective data in quantifiable terms. By implementing an ADCRAM for information system operational test and evaluation, operational evaluators can conduct more accurate, responsive, and cost-effective operational test and evaluations for the Department of Defense.

When Sleds Fly -- Selecting the Best Alternative for Future High Speed Testing at the Holloman High Speed Test Track

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The Holloman High Speed Test Track (HHSTT) is used to create test environments for a wide variety of full-scale test articles, from low-speed ejection seat tests to high speed theater missile defense lethality tests. Current speeds on the track are limited to 2 km/sec, but speeds in excess of 3 km/sec are needed for many types of testing. In addition, the vibrations caused by the metal-to-metal contact on the present track creates a severe environment which requires substantial "beefing-up" of test articles. The metal-to-metal contact also leads to frequent rail damage during high speed runs. The 846th Test Squadron is developing a new facility using magnetic levitation technology to overcome many of the present problems associated with the HHSTT. The facility is expected to be operational in FY99. A Test Capability Benefits Analysis (TCBA) was performed to determine the most cost effective approach to developing the magnetic levitation facility. This paper presents first an overview of the current capabilities and shortfalls of the HHSTT and then shows the TCBA methodology and results used to select the current configuration of the proposed magnetic levitation facility.

*I. **Maritime Airdrop Delivery System: Rigidhull Inflatable Boat (RIB) Cradle***

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The RIB Cradle is a NAVSPECWARCOM project in support of SOCEUR. The cradle allows a 24ft RIB to be loaded aboard a C-130 and airdropped by a Special Boat Unit Detachment into a local area of operation. Two cradles were purchased and tested at Natick Laboratories and airdropped by AFSOC at Hurlburt Field, FL, in early 1996 with an Operational Demonstration following in Europe. The USSOCOM tests represented a coordinated multiservice effort to provide a rapid solution to SOCEURs operational need. In an effort to further extend the NSWCs limited resources, funding for the two UK Manufactured Pre-production cradles was obtained through OSDs Foreign Comparative Test Program Office and allowed the procurement of the remaining 8 RIB Cradles from the realized cost savings.

II. **Integrated Survey Program (ISP)**

The ISP consists of over 25 integrated subsystems that enable SOF Regional Survey Teams to conduct detailed surveys of high interest areas worldwide, process the data and if required, provide immediate dissemination in response to a crisis. Operational Testing will begin in the 4th Quarter of FY96. During this phase, system end-to-end testing will be conducted using SOCSOUTHs Regional Survey Team. The test period will involve pre-mission planning at FT BRAGG, NC a site survey in Panama, post-survey processing at SOCOM and conclude with a EXEval in which SOF Operators will be deployed to the surveyed site in Panama to assess the overall suitability of the ISP data to support a crisis action response. This rapid, yet thorough, testing will ensure that the fielded ISP system is operationally effective and suitable.

Multiprocessor ECM Verification Instrumentation

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This paper describes a multiprocessor system for the real-time measurement and verification of the electronic countermeasures (ECM) emanating from a jammer-equipped aircraft. This Jammer Mode Verification Instrumentation (JMVI) is capable of simultaneously sampling, transforming, and analyzing multiple ECM techniques against multiple threats. The JMVI is composed of a fast-tuning microwave receiver with multiband outputs; a high-speed digital data acquisition system; a parallel-processing computer network for control, analysis, and verification of ECM technique parameters; and a PC-based user interface.

The JMVI measures and verifies the parameters associated with noise, amplitude modulation, frequency modulation, Doppler modulation, and range-based deception techniques. A few of the parameters measured and verified include *pulsewidth, pulse-repetition interval, relative power*, and *technique period*. In its automatic mode, the system provides a pass/fail status that allows an operator to simultaneously monitor multiple threat/ECM techniques responses. In manual mode, detailed data is provided to allow isolation of ECM technique anomalies and failures.

Correlation Methodology

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Correlation is defined as the agreement of test results and estimates of test results. The correlation methodology will be described in the context of a Disciplined Test Process that includes definition of test objectives, predictions, test design, execution, analysis, and archiving of test results. Correlation divided into two types, (1) agreement of exit criteria results (pass/fail) and (2) quantitative assessment of correlation coefficients or confidence limits of the commonality of distribution functions.

Having performed a disciplined test correlation analysis begins with preparation of the test data for correlation. For each test environment (facility) collect and analyze the selected test data. Merge appropriate test data including time synchronization

of data. The test measures and observables from the test data are developed using the data reduction and analysis plan.

Correlation analysis consists of two parts. The initial part is qualitative correlation analysis and the final part is numerical correlation analysis. The consistency or correlation (apparent agreement) of test results is evaluated. If consistency or qualitative correlation is not apparently good, identify the parameters that might be candidates or a basis for reconciling the differences. Using knowledge of the SUT and the test environment reconcile analysis is performed of differences in test results. Finally, numerical correlation analysis is performed. In the case of time-line data numerical assessments of correlation or repeatability consists of the numerical correlation coefficient between the two data series (timelines). In the cases of distribution functions statistical test such as the truncated Smirnov test are performed.

The Impact of Army Reliability Standardization Improvement on Reliability Testing

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During the past few years, the US Army Materiel Systems Analysis Activity (AMSAA) has been at the forefront of Reliability and Maintainability (R&M) standardization reform. At his request, AMSAA briefed Mr. Hollis, the Deputy Under Secretary of the Army (Operations Research), on 9 June 1995 concerning the status of reliability standards reform, particularly as it relates to the development of a performance-based(i.e., non "how to") approach to reliability in Army acquisitions. This briefing was subsequently given to other senior Army leaders including Dr. Oscar (Deputy Assistant Secretary of the Army for Procurement) and Dr. Fallin (Deputy Assistant Secretary of the Army for Assessment and Evaluation).

In a 27 September 1995 memorandum to the Army acquisition community, Dr. Oscar, in his capacity as Army Standardization Improvement Executive, designated AMSAA his Executive Agent for R&M Standardization Improvement. This was done in order to provide a single Army focal point for the development, refinement and implementation of a performance-based approach to R&M in Army acquisitions. A key area being addressed is reliability testing and evaluation.

Requirements for reliability testing are specified in Requests for Proposals (RFP) in order to verify the achievement of quantitative reliability requirements. In the future, reliability testing "how to" will not be specified in RFPs (e.g., specifying particular models or statistical test plans). Reliability testing requirements should be specified in terms of quantitative reliability requirements and allowable uncertainties and risks (e.g., probability intervals, statistical-confidence limits and hypothesis-testing risks). RFPs should contain language that will ensure that information sufficient for evaluating source data, models, reasonableness of assumptions, methods, results and uncertainties is provided to the Army.

Defining Testable, Operational Requirements for Information System Evaluation -- A Task Level Paradigm.

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Traditionally, the operational requirements document (ORD) is the vehicle for defining operational requirements and its customers are the system program office and the operational test agency. As such, it behooves the ORD customers to furnish the ORD supplier guidance on preparing testable requirements to develop viable information systems. The ORD comprises eight sections for information systems. Section one -- the general description of operational capability -- covers the information system mission area, the mission area need, and joint potential and multinational applicability. Section two -- the threat section -- covers both threat engagement and threat vulnerability for the information system. Section three -- the shortcomings of existing systems section --covers status quo deficiencies as well as shortfalls to modification options in meeting mission needs -- doctrine, operational concepts, tactics, organization structure, or training. Section four -- the capabilities required section -- covers the operational effectiveness and suitability critical operational issues, effectiveness, and performance thresholds with regard to the tasks the system must support effectively. Section five -- the integrated logistics support section -- covers maintenance planning, support equipment, human systems integration, computer resource requirements, and other logistic considerations Section six -- the infrastructure support and interoperability section -- covers C4I, transportation and basing, standardization, interoperability, and commonality, mapping, charting, and geodesy support, and environmental support. The final two sections cover force structure and schedule considerations, respectively. Given well-defined, testable operational requirements early in the acquisition process, the system program office can better develop task-oriented information systems in a timely and cost-effective manner, and the operational test agency can conduct more accurate, responsive, and cost-effective operational test and evaluations for the Department of Defense.

WG 21 — UNMANNED SYSTEMS — Agenda

Chair: MAJ Edward Kleinschmidt, USMA
Cochairs: MAJ Harvey Graf, AMSAA
Mr. Robert Elich, Summa Technology
Mr. Patrick Wheeler, AF Studies and Analysis Agency
MAJ Jerry Diaz, Defense Airborne Reconnaissance Office
Advisor: Mr. Brad W. Bradley, AMSAA
Room: GIF, 352-B

Tuesday 1030 - 1200 - **Open Panel Discussion**

Assessing Unmanned Ground Vehicle (UGV) using Combat Situation
MAJ Harvey Graf, AMSAA

Program Overview of TTCP KTA-21: Operational Assessment of Battlefield Robotics
Mr. Brad W. Bradley, AMSAA

Tuesday 1530 - 1700
Enhanced Modeling Techniques for Simulation of Evolving Technologies
Mr. Kevin Young, TRAC White Sands

An Analysis of Teleoperation Work Load
Mr. David R. Scribner, AMSAA

Human Performance Measures for Teleoperated Systems
Mr. Thomas W. Haduch and Lisa Mason, Army Research Laboratory

Wednesday 0830 - 1000
Evolution of HMMWV- based Operator Control Unit
Mr. David W. Scribner, Army Research Laboratory

Capability Assessment of the Hunter Predator Unmanned Aerial Vehicle
Mr. William Clay, AMSAA

Unmanned Aerial Vehicle Applications for Counterproliferation and Arms Control Monitoring
Mr. John S. Kelsey, et. al., TASC, Inc.

Wednesday 1330 - 1500
From Virtual Reality in Longbow Testing to Tools for Improved After Action Reviews
Mr. Mike Tedeschi, et. al, Test and Experiment Command Experimentation Center, Ft. Hunter Liggett

Unmanned Aerial Vehicle Survivability: An Overview
Ms. Mary Horner, et. al., TRAC Leavenworth

Tactical UAV Users Demonstration, Operational Effectiveness Analysis
Ms. Mary Horner, et. al., TRAC Leavenworth

Wednesday 1515 - 1645
AFSAA Unmanned Aerial Vehicle Studies
CPT Kate Kleman and LTC Milburn, USAF Studies and Analysis Agency

Unmanned Ground Vehicle Employment Analysis
Mr. Robert Elich, Summa Technologies

Thursday 0830 - 1000
COMPOSITE GROUP V SESSION .... GIF, Dupuy Auditorium

Thursday 1030 - 1200 - ***Overflow Date*** - ***Use of UAVs*** - Chuck Davis

Tuesday 1030 - 1200 - ***Open Panel Discussion***
Assessing Unmanned Ground Vehicle (UGV) using Combat Situation

MAJ Harvey Graf
US Army Material Systems Analysis Activity
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Unmanned ground systems are an emerging technology with a tremendous potential impact on the future battlefield. As research on these systems continues, a firm understanding of tactical employment considerations must be developed to help maintain the focus of the tech base community. A critical aspect of this is developing the ability to operationally assess any systems that result from the research and development process.

The United States, United Kingdom (UK), Canada, and Australia are members of The Technical Cooperation Program formed to share information between member countries. Under this program, a Key Technical Area (KTA) emerged to explore the operational assessment of battlefield robotics. The US Army Materiel Systems Analysis Activity (AMSAA) and the British Defense Research Agency (DRA) have the operational lead for UGV analysis.

The key to successfully assessing the contribution of UGVs on the battlefield is finding analytic methods that fairly capture UGV performance. The KTA is examining UGV systems performing Reconnaissance, Surveillance and Target Acquisition (RSTA) and minefield breaching missions using traditional force-on-force combat simulations (the US is using the Combined Arms and Support Task Force Evaluation Model (CASTFOREM)). The KTA will identify the strengths and weaknesses of using the force-on-force modeling approach and, if possible, propose changes and improvements to UGV modeling and simulation procedures.

This presentation provides an overview of this UGV modeling and simulation effort and a look at emerging results.

Program Overview of TTCP KTA-21: Operational Assessment of Battlefield Robotics

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The Technical Cooperation Program (TTCP) WTP 6 Subgroup approved the formation of Key Technical Area (KTA) 21 addressing operational assessment (OA) of robotics on the battlefield. Four nations (US, UK, Canada, Australia) are involved, with the US (ARPA and AMSAA) and the UK (MOD and DRA) taking the management and technical lead, resp. The TTCP leadership agreed that the exchange of OA information on the utility of robotics in potential common mission areas would greatly assist in robotic requirement definition and tech base development.

ARPA (the US TTCP Technology Focus Officer) is funding the US TTCP robotics effort with AMSAA as the TTCP OA study lead. A Technical Seminar Wargame (TSW) was conducted prior to initiating constructive simulation to evaluate a number of concepts in a number of scenarios ranging from peacekeeping urban settings to full scale conflict. The results of the TSW will feed into the combat simulation portion of the effort by playing a selected number of concepts in scenarios obtained from TRADOC.

The initial analysis will address the robotic Reconnaissance Surveillance and Target Acquisition systems as well as minefield proving and breaching concepts. The results of the TSW will define the final set of robotics system parameters for the study. This paper will provide an overview of the work to date and the future activities scheduled.

Tuesday 1530 - 1700
Enhanced Modeling Techniques for Simulation of Evolving Technologies

Mr. Kevin Young,
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The purpose of this paper is to illustrate the versatility of CASTFOREM in its ability to capture the fidelity and complexity of simulating evolving technologies for statistical evaluation. The modeling techniques used to illustrate these are the CR-UAV Target Location Accuracy (TLA) evaluation, the effects of simulating crew coordination in armored fighting vehicles, and the simulation of unmanned ground vehicles in a counter reconnaissance role. Other modeling techniques included: shoot and scoot modeling of MLRS and red artillery; complex battalion, company and platoon maneuver formations in a movement to contact operation; red air defense coordination and suppression logic; dynamic use of mortar smoke to provide obscuration in open areas and breeching operations during ground maneuvers; and indirect fires on single high priority targets.

These techniques are modeled in Southwest Asia high resolution scenarios. The TLA for the CR-UAV was evaluated by examining a segment of the battle in HR29.17 where the aerial vehicles encounter a target rich environment in a FASCAM minefield. Crew coordination modeling includes the search techniques of the commander and gunner, the designation of the target by the commander, the munition selection based on the gun-target range, the type of target, and the characteristics of the fire control system. The unmanned ground vehicles are used to position counter recon forces into battle positions that overwatch the advancing enemy recon elements.

Information obtained from the unmanned ground vehicles allow the counter recon elements to maneuver to selected battle positions for concentration of fires on the advancing enemy. The other modeling techniques illustrate tactical operations and maneuvers that required complex decision logic to depict.

An Analysis of Teleoperation Work Load

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Recent quality increases of sensory feedback for teleoperation are allowing greater sensory immersion for the teleoperator. High speed

and off-road driving conditions are critical teleoperator performance hurdles. The primary challenge to the development of good teleoperated systems is the basic driving task, essential to the delivery of a mission package. The Human Research and Engineering Directorate of the U.S. Army Research Laboratory is involved with the advance of sensory feedback technologies in teleoperated systems and examines the effect of these technologies on teleoperator performance. Several driving models reflecting different sensory feedback modes were built in MAN-SEVAL, a module of HARDMAN III.

Seven models were built in all, including one baseline model of on-board driving. The six other models consisted of low level feedback, binaural feedback, force feedback, stereovision, wide field of view, and all teleoperated feedback combined. These models have identical functional and task flow structures; however, task work loads were altered in each model based upon the impact of the sensory feedback technology. The purpose of this effort was to 1) define the functions and tasks of the teleoperated driver, 2) formulate teleoperated driving models to assess the teleoperator's driving work load under varying sensory feedback conditions, and 3) develop a prediction tool for the impact of technology on teleoperator workload.

Iterative model executions provided data that yielded significant differences between on-board and teleoperated work load as well as among work load for teleoperated models only.

Human Performance Measures for Teleoperated Systems

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The Human Research and Engineering Directorate (HRED) of the U.S. Army Research Laboratory is presently exploring the use of robotic and teleoperated systems for a wide variety of future mission areas where it is undesirable to expose the soldier to a hostile environment. To date, human performance has been a constraint on providing a feasible system. The current technology has only allowed proof-of-concept prototype systems to be developed. A greater understanding of the human operator's interface with such systems is required to provide system engineers with guidance regarding control and display design. Without such an understanding, a significant technical risk arises in the matching of control system features with human ability. The present research responds to this need through the focused investigation of human processes associated with robotic and teleoperated system control.

Teleoperation refers to operating a machine that extends a person's sensing and manipulating capability to a location remote from that person. The purpose of the research is to quantitatively explore aspects of the soldier's visual system (e.g., attention, object detection and recognition) that relate to the task demands associated with controlling a teleoperated system. Design feedback characteristics (e.g., field of view, image compression and resolution, color, motion detection, stereopsis, frame update rate) are investigated in terms of their effects upon critical properties of the human visual system and operator performance.

The technical challenge is to cost-effectively provide the operator with the optimum control feedback. The specific teleoperation task being studied is remote driving of a vehicle via indirect viewing of the vehicle's environment through sensors mounted on the remote vehicle. HRED currently has testbeds with state-of-the-art technology available for data collection. Human performance is measured through a variety of means in order to quantify it in terms of meaningful system requirements.

These results are further being used to develop models of human behavior. The human is a complex system that does not always respond in a predictable way. An attempt is being made to understand the human processes used in a complex task situation such as navigation of a teleoperated vehicle and to apply this understanding to predictive modeling of other complex operations.

Wednesday 0830 - 1000
Evolution of HMMWV - based Operator Control Unit

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The purpose of this paper is to document the progress and design efforts that led to the present HMMWV-based OCU configuration. The efforts were directed toward increasing the quantity and quality of sensory feedback modes to the operator in order to allow the operator to drive at higher speeds and during off-road conditions. These technical challenges were identified as critical teleoperator performance hurdles after DEMO I - Office Secretary of Defense demonstration of state-of-the-art robotics technology. Secondary efforts were directed towards achieving a mock-up control station which supports Project Manager Unmanned Ground Vehicles' (PM UGV's) concept of a two-HMMWV teleoperations unit; the telerobotic HMMWV is configured for teleoperated driving, while being driven from a control station in the other HMMWV. Additionally, the control vehicle is to look like any other fastback HMMWV.

A study is in progress to examine the effectiveness of different visual feedback modes in teleoperation: a multicamera, mulitmonitor setup for enhancing the driver's peripheral vision; stereoscopic vision for depth perception; and both simultaneously. By including a baseline condition of one camera, one monitor, monoscopic vision, a two-by-two factorial experimental design will be employed. With time and errors as dependent variables, an analysis of variance can be applied to determine significance.

The Army Research Laboratory (ARL) focus program is an inter-laboratory effort among several directorates to provide mid-term telerobotic technology to the customer, which includes PM UGV at Missile Command, Belvoir Research and Development Center Off-Route Smart Mine Clearing, Advanced Research Projects Agency, and ARL directorates of S3I (Sensors, Signatures, Signal, and Information Processing), and Weapons Technology.

Capability Assessment of the Hunter Predator Unmanned Aerial Vehicle

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This report contains the methodology and results of performance analysis efforts by AMSAA to assess the capabilities of the Hunter and Predator Unmanned Aerial Vehicle (UAV) to support a Tactical UAV User Demonstration. The purpose of the Tactical UAV User Demonstration was to assess the ability of the Hunter and Predator systems to satisfy the tactical commander's intelligence requirements. The first section assesses the performance of the TV and forward looking infrared on Hunter and Predator as a function of slant range. The second section assesses the performance of the Predator systhetic aperture radar as a function of slant range. The third section determines the relative system effectiveness of Hunter and Predator performing the Army Short Range UAV mission, given equal cost deployments of the two systems.

Unmanned Aerial Vehicle Applications for Counterproliferation and Arms Control Monitoring

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Abstract Unavailable at Print time

Wednesday 1330 - 1500
From Virtual Reality in Longbow Testing to Tools for Improved After Action Reviews

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Approved abstract not available at printing.

Unmanned Aerial Vehicle Survivability: An Overview

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Unmanned Aerial Vehicles have been designed to operate at different echelons of command and meet the different reconnaissance, intelligence, surveillance and target acquisition (RISTA) requirements of those echelons. In the spring of 1995, the Assistant Secretary of the Navy (Research, Development and Acquisition), initiated the Tactical UAV Users' Demonstration. The Users' Demonstration's purpose was to evaluate the Short Range UAV (SR-UAV) Hunter and the Medium Altitude Endurance UAV (MAE-UAV) Predator to determine each system's ability to meet joint tactical commanders' intelligence and target acquisition requirements. During the course of the operational effectiveness analysis, the vulnerability of the UAV to threat air defenses became a critical issue.

This paper presents the results of an analysis of UAV vulnerability to likely threat air defense systems using previous survivability analyses; current threat force and system capabilities information; and UAV technological and test data. In addition, the paper discusses the UAV countermeasures that would be most suitable for further development.

Tactical UAV Users Demonstration: Operational Effectiveness Analysis

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The family of Unmanned Aerial Vehicles has traditionally been divided into several groups of systems that operate at different echelons of command in order to meet different reconnaissance, intelligence, surveillance and target acquisition (RISTA) requirements. In the spring of 1995, the Assistant Secretary of the Navy (Research, Development and Acquisition), with the involvement of the Joint Requirement Oversight Council (JROC), initiated the Tactical UAV Users' Demonstration. The Users' Demonstration would evaluate the Short Range UAV (SR-UAV) Hunter and the Medium Altitude Endurance UAV (MAE-UAV) Predator to determine each system's ability to meet joint tactical commanders' intelligence and target acquisition requirements. In addition, the demonstration would also examine the synergy and interoperability between the two systems.

The Users' Demo methodology combined operational testing of the alternatives with constructive simulation aimed at those functions and characteristics that were not feasible to test. This paper presents the methodology and results of the Operational Effectiveness Analysis portion of the overall Users' Demo. It discusses several concepts that were developed during the course of the study including UAV operational concepts and the difficulties in measuring the contribution of UAVs.

Wednesday 1515 - 1645
Assessment of the Metric Model -- And its Use in Studying Unmanned Aerial Vehicles

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Approved abstract not available at printing.

Unmanned Aerial Vehicle Contributions to Transporter Erector Launcher Detection and Targeting Activities

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Approved abstract not available at printing.

Tactical Unmanned Vehicle Employment Analysis

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Approved abstract not available at printing.

Thursday 1330 - 1500
Overflow Date
Use of UAVs

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Approved abstract not available at printing.

AFSAA Unmanned Aerial Vehicle Studies

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Approved abstract not available at printing.

WG 22 — COST AND EFFECTIVENESS ANALYSES — Agenda

Chair: LTC(P) Bob Clemence, OSD PA&E
Co-Chair: Mr. Ron Magee, USA TRAC
Advisor: Mr. Mark Cancian, OSD PA&E
Room: GIF, 352-A

Tuesday, 1030-1200
Tactical UAV User's Demonstration: Operational Effectiveness Analysis
CPT Michael Teague, Mary Horner, and CPT Dan Selph, USA TRAC

An Approach for Providing Linkage for Electronic Combat Systems Cost and Operational Effectiveness Analyses
LtCol Jim Neuhard, USAF TSS/DO & John Gibbons, SRE, Georgia Tech Research Institute

Tuesday, 1530-1700
A Groupware Approach to Risk Analysis and Management
Bruce Miller, Vector Research, Inc.

Architecture Reporting and Monitoring System (ARMS)
R. H. Weber, R. Crawford, Capt S. Thomason and Capt W. Hulett, USAF SMC/XRE

Wednesday, 0830-1000
Refitting or Replacing Army Equipment: Quantities and Scheduling
MAJ Peter Davidson, USA DCSOPS - Force Development & Mr. Andrew Kourkoutis, USA CAA

QUICK STRIKE Munitions Model Development And Capabilities
Capt Paul Campbell, AFMC OAS & Maj Kirk Yost, Naval Postgraduate School

Wednesday, 1330-1500
Strategic Airlift Force Mix Analysis (or When is a COEA not a COEA?)
Mr. Dave Merrill, USAF AMC/XPY

Advanced Field Artillery Tactical Data System (AFATDS) Milestone III COEA
Mr. Ross Wells and Dr. Jimi Whitten, USA TRAC

Wednesday, 1515 - 1645
Total System Ship Design in a Supersystem Framework
Mr. William Hockberger, Consultant

Thursday, 0830-1000
COMPOSITE GROUP V SESSION .... GIF, Dupuy Auditorium

WG 22 — COST AND EFFECTIVENESS ANALYSES — Abstracts

Tuesday, 1030-1200
Tactical UAV User's Demonstration: Operational Effectiveness Analysis

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The family of Unmanned Aerial Vehicles has traditionally been divided into several groups of systems that operate at different echelons of command in order to meet different reconnaissance, intelligence, surveillance and target acquisition (RISTA) requirements. In the Spring of 1995, the Assistant Secretary of the Navy (Research, Development and Acquisition), with the involvement of the Joint Requirement Oversight Council (JROC), initiated the Tactical UAV Users' Demonstration. The Users' Demonstration would evaluate the Short Range UAV (SR-UAV) Hunter and the Medium Altitude Endurance UAV (MEA-UAV) Predator to determine each system's ability to meet joint tactical commanders' intelligence and target acquisition requirements. In addition, the demonstration would also examine the synergy and

interoperability between the two systems.

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An Approach for Providing Linkage for Electronic Combat Systems Cost and Operational Effectiveness Analyses

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In the process of acquiring Electronic Combat (EC) equipment, supporting milestone decisions is a challenge. The major challenge is in using EC system test results in accordance with the EC Test Process to clearly link the military worth of the EC system being developed to the operational requirements. The document that should establish this linkage is the Cost and Operational Effectiveness Analysis (COEA).

The 53D Wing has been directed to establish capability to produce COEAs for EC systems which provides this important linkage element. The ability to correlate results of tests with analytical predictions or previous test results used in the COEA is an essential ingredient of a cost effective acquisition process. For the COEA process, this paper presents an approach for implementing analysis methodology for self-protection electronic countermeasure systems (SPECS) that provides linkage with operational testing to quantify the worth of the system for the decision makers.

The use of existing analytical tools to determine the outcome of potential encounters between radar directed weapon systems and targeted aircraft are presented. The analytical approach for processing the resulting data in determining the measure of effectiveness (MOE) for surviving an encounter is based on the probability of each weapons performance. The MOEs are linked to mission success using a comparison of the ratio of probabilities obtained for the same encounter conditions with and without the EC system. The methodology for implementing this analytical approach is presented for a SPECS. Implementation of the methodology also provides the linkage between the analysis and operational tests. This linkage is presented using correlation techniques. The application of the results for estimating system worth for the decision maker is presented for the example system as a product of the factors used in the cost analyses.

<u>*Tuesday, 1530-1700*</u>

A Groupware Approach to Risk Analysis and Management

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The military's technological advancements greatly depend on software and hardware development. Today's hardware and software projects are often characterized by extended schedules, and increasing budgets. Risk analysis and management are critical to improving the performance of software dependent acquisition programs. Risk analysis requires a combination of objective and subjective assessments from personnel concerning the probability of an event occurring. Risk management requires the interactions of members of the program office as new mitigation strategies are developed that have cost and operational considerations. The output from risk analysis and management are primary inputs to assessing the uncertainty in the cost and expected performance of a program.

A major problem in the past has been the lack of an efficient way to facilitate communications among the personnel providing inputs (identification of risks and their impact) and those responsible for managing the mitigation development process. A more dynamic approach is needed to identify risks, assess impact, develop mitigation strategies, and track and update those risks strategies throughout the life cycle of the program.

A team at Vector Research, Incorporated (VRI) has developed a database application in Lotus Notes to facilitate the risk identification, evaluation, and mitigation process. Lotus Notes is a groupware software developed by the Lotus Development Corporation. The distributed nature of the database software allows personnel to access the database and comment on risks from a variety of locations in a near-real-time environment. Thus, the database becomes a truly interactive piece of software to those internal and external to the program office, providing records of comments and changes as the users review and update the documents within the database. Originally designed to track generic risks for a large automated information system (AIS) for the Department of Defense (DoD), VRI's risk management tool (RMT) is flexible enough to encompass the software needs for major weapons systems involving the development of embedded software. The RMT assists managers by identifying potential risks and by providing a means for management of work group activities during the assessment and mitigation phases of risk management.

The RMT utilizes a risk taxonomy crated by the Software Enterprise Institute (SEI). The taxonomy, categorizes risk according to criteria established by the AIS system life cycle. The risks are reviewed and evaluated through numerous processes, such as brainstorming, JAD sessions, and program documentation analysis. The RMT database is linked through the "@Risk" analysis tool into the OSD (PA&E) cost element structure that has been implemented in Microsoft Excel. Consequently, the RMT enhances quantifying the amount of uncertainty in the economic analysis.

Our paper will describe the groupware based RMT and how it enhances the risk management process. We will explain how the tool leverages specific, successful risk management techniques including the risk taxonomy in a groupware environment. The paper also highlights the advantages of using this tool for managers and system developers. These advantages include improved

communication and sharing of risk information among team members, leveraging the results of past risk management efforts on current projects, and support for repeatable risk management process. The RMT also aids in the quantification of risks as an input to economic analyses, identifies those elements that trigger other risks, aids in developing a mitigation strategy, and invites near-real-time interaction through the use of its groupware properties.

These attributes of the RMT demonstrate the advantages to be gained through its use. The advantages have already been successful in development of a large AIS for DoD. This success should encourage use of the RMT for other software development disciplines within the military.

Architecture Reporting and Monitoring System (ARMS)

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As we seek to make significant efficiencies in military systems acquisition it becomes increasingly important to consider architecture alternatives and cost-effectiveness tradeoffs at the macro or "system-of-systems" level. Organizations involved in planning the future evolution of military space systems capabilities are primary customers for a graphically controlled, computer-based decision support application that compensates for human handicaps in short term memory to facilitate decision-oriented analysis at a highly aggregated level. This handicap makes it difficult to navigate through multi-dimensional data bases, to search for patterns that allow clustering of similar functions and to repartition physical components that reduce unaffordable redundancy and fit development budget into a time-based context of evolving threat and FYDP constraints. Because of the many stakeholders involved the Pentagon budget process, it is also desirable that such a decision support system operate in real-time to facilitate discussion and negotiation among competing interest. In this way, a collaborative process might produce a master plan which is a satisfactory compromise in not only political, but also engineering terms.

Given those broad functional parameters of a decision support system for space systems architecture, SMC/XR has been developing a software application for the real-time, interactive decision support. The Architecture Reporting an Monitoring System (ARMS) is a customized integration of commercial off-the-shelf software with a special purpose object-oriented interface that allows users to navigate rapidly through data downloaded from a network server and assess such "what ifs" as schedule slippage from one FY to the next, program cancellation, stretchout of critical technology development, launch failure or transition of the architecture to a new generation of launch vehicles.

Wednesday, 0830-1000
Refitting or Replacing Army Equipment: Quantities and Scheduling

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A key component in many procurement programs is when to field and at what rate to produce major systems because America's solders, sent into battle, must have modern equipment capable of affording them both a technological advantage over their adversaries and the ability to support continuous battlefield operations. Fielding modern equipment is a continuous process over time. Because the Army is equipment intensive, the fielding schedule is extensive. The Army's current fleet of 258,000 tanks, infantry fighting vehicles, artillery, helicopters, and tactical trucks is larger than almost all commercial fleets.

This study develops a methodology for evaluating when and the what rate to field new equipment on the basis of fleet age and technology, and for determining the approximate level of RAD funding needed to achieve the Army's long-term fielding goals. The methodology revolves around a system's Refit or Replace (R2) point. This is the age at which a piece of equipment will no long be mission capable in sufficient capability or (in the case of combat systems) will not retain a technological advantage over similar equipment. At each such point in a system's life, a decision must be made on whether to refit (i.e., rebuild/upgrade) or replace (i.e. buy more of the same or a field a new system). Historically, the R2 point occurs at 8-10 year intervals for most systems. The methodology portrays the impact of alternative R2 decisions over time. Fielding decisions made now will continue to impact subsequent decisions over the next 20 years.

QUICK STRIKE Munitions Model Development And Capabilities

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The Air force has historically maintained four different munitions allocation models to support POM estimates, operations planning, and requirements studies for weapons. The use of different models often led to inconsistent results, creating confusion in the

munitions community and Air Force. In addition, each model required data in its own unique format, forcing each using organization to crate largely duplicate databases. In March 1995, the Air Force formed the Munitions Model Working Group to consolidate three of the existing munitions models (TAM, HEAVY ATTACK, and MIXMASTER) into a single model now known as QUICK STRIKE. This consolidation has allowed the best aspects of the original models to be combined with many new ideas for this class of campaign analysis tools. This presentation will address the development of QUICK STRIKE model and provide an overview of QUICK STRIKE's capabilities. QUICK STRIKE is an optimization, but models stochastic factors such as target regeneration, weather, and battle damage assessment. A few of the key capabilities include the ability to model simultaneous major regional conflicts, the ability to control CONOPS in the model, and a goal-oriented approach to optimizing the allocation. We will discuss our current experience with QUICK STRIKE and its use in determining Air Force FYDP munitions requirements.

Wednesday, 1330-1500

Strategic Airlift Force Mix Analysis (or When is a COEA not a COEA?)

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The Defense Acquisition Board (DAB) that met in November 1995 made an acquisition decision to procure 80 additional C-17s (for a total 120) and deferred any decision on C-33 type aircraft pending further studies on accelerated C-17 acquisition profiles and the CRAF. The Strategic Airlift Force Mix Analysis (SAFMA) was the "tailored cost and operational effectiveness analysis" called for to support this Milestone III acquisition decision. The degree of "tailoring" in the SAFMA and the contributions of alternative analyses (like the OSD/PA&E Tactical Utility Analysis or TUA) approached the structure of a formal COEA for a DAB in a very different manner. Integral to the "COEA" was the source selection of an NDAA, an evolving requirements definition in the MRS-BURU, and directed requirements to improved existing modeling capability. This presentation discusses the advantages and pitfalls of abandoning a structure COEA process in favor of a more "streamlined, business-like approach" to providing analysis support to a DAB.

The types of questions and issues addressed in this presentation include:

Linking A COEA With A Source Selection:

I. Where data comes form and how good is it?
II. Who has access to data?
III. Who accomplishes the analysis?
IV. Who can see the results?
V. How to link the efforts of many different agencies?
VI. Getting around the requirements for formal coordination.
VII. Saying "good-bye" to the TAG and COG.

Measuring Ops Effectiveness In A Meaningful Way:

I. Coping with scenario uncertainties and assumptions.
II. Model development initiatives to get at required details.
III. Evolving measures of merit and changes to an approved study plan.
IV. What is moderate risk and how do you measure it?
V. Distinguishing between force sizing and force mixes.
VI. How many airplanes (NDAA & V-17 breakpoints)?
VII. Should a COEA last two years? Maybe longer?
VIII. Dealing with an infinite number of unknown alternatives.
IX. How long is a life cycle?
X. "Waiving" Milestones for two different programs.
XI. What is "non-developmental?"

Measuring Cost In A Meaningful Way:

I. Cost analysis with no R&D and no disposal/replacement costs.
II. The difference between sunk costs and common costs.
III. Handling cost data from multiple sources.
IV. Costing modifications outside the COEA alternatives (C-5 mods).
V. Comparing force mixes rather than aircraft types.
VI. Covering the spectrum of possible questions.

Advanced Field Artillery Tactical Data System (AFATDS) Milestone III COEA

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The TRADOC Analysis Center (TRAC) conducted the Advanced Field Artillery Tactical Data System (AFATDS) Milestone III cost and Operational Effectiveness Analysis (COEA) to provide analytical support for the Milestone III Army System Acquisition Review Council (ASARC) decision review, 15 December 1995.

The methodology for this COEA included a cyclic use of three different levels of combat model. The artillery portions of the "big picture" obtained from the corps level model were used to add realism and drive the (higher resolution) artillery system level model. Output from this model was, in turn, used to drive (higher resolution) communication level model. The communication level model simulated all artillery communication in minute detail and verified whether or not the communications systems were capable of passing the traffic assumed by the combat models. Where necessary, the high resolution output from the communications model was used to modify the input to the artillery system effectiveness model. The artillery system effectiveness model outputs, in turn, were used as input to the corps level combat effectiveness model.

This presentation will focus on study methodology and results. The COEA considered functionality, operational effectiveness, training manpower implication, dependencies on other Army tactical command and control system (ATCCS) battlefield functional area control system (BFACS), and cost. Final results were briefed to headquarters Department of Army on 7 September 1995, and the final report was completed on 6 October 1995. The study assumed Army of Excellence for structure in the 1999 timeframe for Blue and 2004 for Red in two major regional contingency (MRC) scenarios.

The study examined three alternative systems: Initial Fire Support Automation System (IFSAS), the base case, and two candidate AFATDS systems (V1 and V3). AFATDS V3 provided the greater effectiveness.

Wednesday, 1515 - 1645
Total System Ship Design in a Supersystem Framework

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Naval architect are skilled at turning a set of ship performance requirements into the engineering description of a ship capable of meeting them. That is the technical side of the problem, and our ability to deal with it has steadily improved. But the ship design problem has other major aspects that must be dealt with just as competently if the ultimate result is to be the best, most cost-effective ship possible.

This paper proposes some major changes in the way naval ship design is approached. It provides a high level description of the entire process of early considerable on the traditional boundaries of that process. It places that process in its larger context of mission requirements determination, operational effectiveness assessment, and program management review and control, all of which influence a ship's technical characteristics and capabilities. It outlines the various elements of analysis, design, estimating and assessment involved and shows how they are interrelated and must be worked interactively in comprehensive and systematic process if an optimal ship design is to be achieved.

Interwoven with this expended design process is an expanded context for understanding the role of the ship being designed. This paper introduces the idea of a "supersystem" containing all the other operational systems, facilities and support infrastructure the new ship system will have to operate jointly and compatibly with. It explains why total-system design and optimization must be focused at the supersystem level and not merely at the level of the new ship itself. Since this expanded focus requires looking for factors and effects in areas that have not generally been thought relevant, some principles and guidelines for recognizing them are provided.

The paper clarifies the issues of "measures of effectiveness (MOEs)" versus "measures of performance (MOPs)," and shows how each should be determined and used. It shows how high level MOEs and the design philosophy can be distilled from the mission requirements even before any technical design work has begun. The practical use of modeling and simulation in matching the MOPs of an alternative system concept against the MOEs required by the mission is discussed.

WG 23 —WEAPON SYSTEMS ACQUISITION - REQUIREMENTS ANALYSIS — Agenda

Chair: Mr. Terry Cooney, Veda Incorporated
Cochair: CPT Mickey Sanzotta USMA
Room: GIF, 359-D

<u>*Tuesday, 1030-1200*</u>
Requirements Determination - The Army's Perspective
Mr. Ronnie Brackett, Senior Combat Requirements Analyst, TRADOC Combat Arms, Ft. Monroe

Requirements Determination - The Navy's Perspective
Mr. Greg Melcher, N81 Pentagon

Requirements Determination - The Air Force's Perspective
LtCol Bill Todd, ACC MAST, Langley AFB

<u>*Tuesday, 1530-1700*</u>
NORAD Airspace Control Requirements Study
Mr. Kenneth Cranford, NORAD and USSPACECOM

Fleet Age Recapitalization
Maj Peter A. Davidson, ADCS for Operations and Plans

M1A3 Abrams Main Battle Tank, Bridging the Lethality Gap
Maj Rocky Gay, Department of Systems Engineering, US Military Academy

<u>*Wednesday, 0830-1000*</u>
Making the Soldier More Lethal, The Objective Individual Combat Weapon
Maj Rocky Gay, Department of Systems Engineering, US Military Academy

A Case Study in Revisiting Requirements: The Tactical UAV Users' Demonstration
Ms. Mary L. Horner, CPT Michael Teague, CPT Daniel Selph, TRADOC Analysis Center

Crusader Requirements Analysis
Mr. Joe Stallings, Vector Research

<u>*Wednesday, 1330-1500*</u>
QUICK STRIKE Munitions Development and Capabilities
Maj Kirk A. Yost, Capt Paul W. Campbell AFMC OAS/DRC

Fighter Configuration Plan - A Capital Budgeting Exercise using Quality Functional Deployment and Goal Programming
Mr. Ken Lindsey, ACC/XP-SAS

Navy Air Campaign Analysis with the Weapons Mix Model
Dr. Robert Pendelton, NAWC-WD

<u>*Wednesday, 1515-1645*</u>
An Information Framework for Requirements Management
Mr. Douglas Popkin, Mr. John W. Perkins, Summaria Systems Inc.

Application of the Analytical Hierarchy Process to Requirements Analysis
Richard Nill, Carnegie Group

<u>*Thursday, 0830-1000*</u>
COMPOSITE GROUP V SESSION .... **GIF, Dupuy Auditorium**

Tuesday 1030-1200

Requirements Determination - The Army's Perspective

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Requirements Determination - The Navy's Perspective

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Requirements Determination - The Air Force's Perspective

LtCol Bill Todd, ACC MAST, Langley AFB

Tuesday, 1530-1700

NORAD Airspace Control Requirements Study

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As soon as he assumed command of NORAD, Gen Joseph W. Ashy directed reviews of NORAD missions, operational plans and force structure. Many of CINCNORAD's decisions on these matters relied on the results of this study. The study relied on several NORAD strategic air defense models. These models predict the intercept boundary enforceable with a specific force of fighters, alert bases, and sensor systems. They predict the probability of identification and intercept for intrusions of North American airspace anywhere, at any altitude, and at any airspeed. the NORAD Air Defense Model predicts outcomes of interactions between defensive forces and aggressor forces that can be specified by the user. the plans Directorate, NJ5, and the Analysis Directorate, N/SPAN, worked together to explore the performance of different combinations of aircraft and sensors and different deployment resources. We will present summaries of important results. For example, we predicted the value added by additional interceptors or sensors for enforcing North American air sovereignty. we also assessed the ability of alternative force structures to limit damage from possible bomber and cruise missile attacks on north America. This effort is an exemplary demonstration of analysts working with Combined Command planners and Air Combat elements of both the United States Air Force and the Canadian Forces.

Fleet Age Recapitalization

MAJ Peter A. Davidson
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Because the Army is equipment intensive, the process of keeping the Army modernized is extensive. The recapitalization of the Army's fleet of 258,000 tanks, IFVs, artillery, helicopters, and tactical trucks is larger than almost all commercial fleets. To develop an investment strategy to modernize the Army, the study used a long term, system of systems approach to calculate costs and integrate programs into an investment strategy. The system costs and production cycles lead to several procurement strategies. The current strategy is to buy a little bit of everything. Systems are procured in inefficient and ineffective amounts. Since every system must be bought eventually, some can be bought early and others bought later. One alternative strategy minimized the cost increase of the most expensive system (tanks), then the next most expensive system, etc. This strategy produced the lowest overall costs over time and in the early years, but had significantly greater costs in the out years. Trying to concurrently produce tanks and helicopters breaks any realistic procurement budget.

A more realistic budgeting strategy levels the annual costs. The level cost production option produced tanks in the early years and other systems were added to level the budget over the entire period. While the overall cost of this strategy was higher than the least cost strategy, the overall fleet was maintained at a higher level of modernization. A long term, system of systems approach to modernization insures a well led, trained, and ready force is organized and equipped to achieve decisive victories at any future time and place

M1A3 Abrams Main Battle Tank, Bridging the Lethality Gap

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The Russian Army's latest enhanced Armor lethality technology demonstrated in the new models of their T-80 and T-90 Main Battle Tanks may force the U.S. Army to upgrade its armor program in the next eight years. Russian and Ukrainian armor developments, revealed during and after the Chechnya conflict, include explosive reactive armor (capable of defeating both shaped and kinetic energy rounds), enhanced thermal sights, laser guided ATGMs on T-90s and T-80s, and a mast mounted multi directional radar that launches munitions against approaching ATGMs and destroys incoming projectiles. The U.S. Army needs to intensify its armor capabilities to defeat the growing number of increasing lethal main battle tanks available on the open market. Fort Knox requires the next generation Abrams, M1A3, to extend its fighting capability

by 1000 meters (out to 3 km). There are no plans to conduct a major overhaul of its armor program until the middle of the next century. Thus, the Army will upgrade the current Abrams Main Battle Tank to bridge the growing lethality gap between its armored systems and possible threats. the specific design issues include the main gun size (120../enhancedor 140mm), the rate of fire, autoloader and ammunition capacity. The 140mm may necessitate decreasing both the rate of fire and the ammunition capacity. How will these modifications impact the combat effectiveness of the tank? We will use Janus combat simulations, in various missions and terrain, to analyze and predict the combat effectiveness of future alternatives for the next generation tank, the M1A3.

Wednesday, 0830-1000

Making the Soldier More Lethal, The Objective Individual Combat Weapon

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The American fighting soldier must take advantage of new technology to increase its lethality on the battlefield. We have improved the combat effectiveness of many other battlefield operating systems; yet the foot soldier remains neglected. The U.S. Army Soldier System Command Center (Natick. Mass.), coupled with the Army research Development Engineering Center (Picatinny Arsenal, NJ) want to increase the mobility, survivability, reliability and lethality of the most precious system on the battlefield, the infantry soldier. These organizations have developed the Objective Individual Combat Weapon (OICW) to enhance the lethality of the soldiers, as well as. the infantry squad. Can the Infantry squad be a more lethal and valuable killing asset on the battlefield? How many OICWs are needed on the battlefield? What are the best type of missions to deploy OICWs in? In what type of terrain can the characteristics of the OICW be most effectively utilized to strengthen the "Fightability" of the light infantry squad? Janus combat simulations will be used to evaluate these various organizational, mission and terrain alternatives and situations and determine their effectiveness on the battlefield

A Case Study in Revisiting Requirements: The Tactical UAV Users' Demonstration

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Unmanned Aerial Vehicle programs have traditionally been divided into several groups of systems that operate at different echelons of command and meet the different reconnaissance, intelligence, surveillance and target acquisition (RISTA) requirements of those echelons. In the spring of 1995, the assistant Secretary of the Navy (RD&A) initiated the Tactical UAV Users' Demonstration. The users' Demonstration's purpose was to evaluate the Short Range UAV (SR-UAV) Hunter and the Medium Altitude Endurance UAV (MAE-UAV) Predator to determine each system's ability to meet joint tactical commanders' intelligence and target acquisition requirements. Through operational testing, system performance analysis and operational effectiveness analysis, the demonstration would also evaluate the synergy and interoperability of the two systems at the joint tactical level. This paper presents the history of the Users' Demonstration and the status of the UAV acquisition programs involved, focusing on the operational effectiveness analysis of the Hunter and Predator. In addition, the paper discusses the UAV requirements at the joint tactical level (corps and division) that were examined by the study, the status of existing operational requirements and lessons learned about the relationship between requirements and system acquisition.

Crusader Requirements Analysis

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Approved abstract not available at printing.

Wednesday, 1330-1500

QUICK STRIKE Munitions Development and Capabilities

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The Air Force has historically maintained four different munitions allocation models to support POM estimates, operations planning, and requirements studies for weapons. The use of different models often led to inconsistent results, creating confusion in the munitions community and Air Force. In addition, each model required data in its own unique format, forcing each using organization to create largely duplicate databases. In January 1995, the Air Force formed the Munitions Model Working Group to consolidate three of the existing munitions models (TAM, HEAVY ATTACK, and MIXMASTER) into a single model now known as QUICK STRIKE. This consolidation has allowed the best aspects of the original models to be combined with many new ideas for this class of campaign analysis tools. This presentation will address the development of the QUICK STRIKE model and provide an overview of QUICK STRIKE's capabilities. QUICK STRIKE is an optimization, but models stochastic factors such as target regeneration, weather, and battle damage assessment. A few of the key capabilities include the ability to model simultaneous major regional conflicts, the ability to control CONOPS in the model, and a goal-oriented approach to optimizing the allocation. We will discuss our current experience with QUICK STRIKE and its use in determining Air Force FYDP munitions requirements.

Fighter Configuration Plan - A Capital Budgeting Exercise using Quality Functional Deployment and Goal Programming

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Approved abstract not available at printing.

Navy Air Campaign Analysis with the Weapons Mix Model

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The Weapons Mix Model (WMM) developed as a module of the Analysis Workbench at NAWCWD, China Lake is modified to apply to the question of acquisition of the Joint Air-to-Surface Standoff Weapon, JASSM. Modifications include enhancement of survivability modeling, target apportionment, and flexible prioritization of combinations of existing and projected weapons to kill a prioritized target set quickly, safely and at a low cost. WMM includes detailed representation of air strikes, with complete support packages, from Navy carriers and Marine Corps air bases. Weapon lethality values can reflect a wide variety of launch aircraft and delivery profiles and several environmental conditions. survivability modeling reflects mission planning for threat avoidance, and is correlated with SUPPRESSOR. Running on a Macintosh computer, WMM produces a feasible mix of weapons to accomplish the campaign, which may consist of thousands of targets (WMM has been modified to incorporate the standard NCAA target types). By constraining the answer to win the campaign faster, cheaper, or with less aircraft attrition, the analyst can discover the weakest point of the baseline set of weapons and thereby establish the requirements for proposed new weapons systems.

Wednesday, 1515-1645
An Information Framework for Requirements Management

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The development and management of the operational requirements of large systems is a complex and labor intensive process. The Air Force uses a highly structured process guided by Air Force Instruction 10-601, Mission Needs and Operational Requirements - Guidance and Procedures. The process centers around the production and revision of key documents such as the Operational Requirements Document. However, a document centered approach to requirements management may not provide sufficient visibility to individual requirements and other relevant information elements. An Armstrong Laboratory sponsored research and development effort, Requirements Analysis Process in Design for Weapon Systems (RAPID-WS), is addressing this and related issues through an information centered approach. RAPID-WS operates on an object-oriented data base containing a hierarchy of requirements-related information elements. Elements may be simple or compound. Each element is tracked and maintained separately via specially designed access control and configuration management mechanisms. Relationships between information elements are also captured within the database. The system can maintain multiple versions of the information elements; where each version represents the state of the element at a point in time chosen by the user. The system allows the user to associate requirements with key milestones. The RAPID-WS concept has been implemented as a robust software prototype operating on personal computers. This presentation describes the information framework used within the RAPID-WS implementation. It will also describe the key mechanisms used by the system to automate the requirements management process, enforce consistency and completeness, and enable requirements traceability. The RAPID-WS project is sponsored by Human Systems Center (AFMC), Armstrong Laboratory, Logistics Research Division, Wright-Patterson AFB OH 45433-6503.

Application of the Analytical Hierarchy Process to Requirements Analysis

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Evaluation of a set of alternatives is a common problem which occurs frequently in a requirements analysis effort. In order to determine the most appropriate set of requirements, a decision maker compares alternative requirements sets on the basis of a number of criteria including cost, performance and logistics considerations. In this paper we present a framework which incorporates a computer based evaluator to aid requirements analysts in comparing alternative sets of requirements. This approach is defined in the context of the Requirements Analysis Process In Design for Weapon Systems (RAPID-WS) program. RAPID-WS is a weapon systems requirements management and analysis tool that is currently under development by the air Force Armstrong Laboratory, Logistics Research Division. The alternative evaluator, the focus of this paper, uses the analytical Hierarchy Process (AHP) to determine the most viable alternative. AHP is a popular technique for determining the relative worth among a set of alternatives. AHP involves the decomposition of a decision making problem into a hierarchy, where the root of the hierarchy is the decision issues and the bottom level of the hierarchy is a set of alternatives to be compared. Intermediate levels of the hierarchy contain the evaluation criteria. We describe the architecture and functionality of the alternative evaluator and its integration within the overall framework of RAPID-WS. We also describe how the alternative evaluator uses the information contained within the requirements sets to suggest evaluation criteria which can be used for the analysis. Finally we illustrate the operation of the alternative evaluator via a simple example.

WG 24 — SOFT FACTORS IN MILITARY MODELING AND ANALYSIS — Agenda

Chair: William Pugh, Naval Health Research Center
Co-chairs: Ronald Laughery, Micro Analysis and Design
COL John Silva, ARPA
Christopher Blood, NHRC
Advisor: Eugene P. Visco, SAUS-OR
Room: GIF, 351-B

Tuesday, 1030-1200
Using Fuzzy Logic to Model Human Behavior
George R. Mastroianni, Natick RDEC and Victor E. Middleton, Natick RDEC

Representing Physical Fatigue in Navy Combat Models
James A. Hodgdon, Ph.D., Naval Health Research Center and Ross R. Vickers, Ph.D., Naval Health Research Center

Tuesday, 1530-1700
Technology Leverging For Trauma Care
Col John Silva, ARPA

Wednesday, 0830-1000
Projecting Battlefield Casualties: Incorporation Socio-Cultural and Other Adversary-Specific Factors
Christopher G. Blood, Naval Health Research Center and Daniel Rotblatt, Dr. William Darryl Henderson, Dr. Brian G. McCaughey, Naval Health Research Center

Wednesday, 1330-1500
Breaking The OOTW Scenario Development Paradigm
Capt Erik T. Blechinger, TRADOC Analysis Center, Scenario and Wargaming Center

Navy Combat Leadership For Tomorrow: Where Will We get Such Men and Women?
James John Tritten, Ph.D., Naval Doctrine Command

Wednesday, 1515 - 1645
COMPOSITE GROUP VI SESSION .... GIF, Dupuy Auditorium

Thursday, 0830 - 1000
Integration of U.S. Marine Air-Ground Task Force Tactical Warfare Simulation and the Medical Analysis Tool: Phase One
Jamie Pugh, Naval Command Control, and Ocean Surveillance Center; Research Development, Test, and Evaluation Division

Design Considerations for Virtual Combat Medicine Trainers
Annette L. Sobel, LTC, (SFS), MC, USAF/Sandia National Laboratories, NM, Sharon A. Stansfield, Ph.D., Sandia National Laboratories

Thursday, 1330-1500
Methodology for Quantifying Foreign Ground Force Performance Factors
Gerald A. Halbert, National Ground Intelligence Center (NGIC)

Determination of Detection Ranges of Woodland Mobile Camouglage For The MI Abrams Task
George Anitole, Ronald Johnson, and Christopher Neubert, Night Vision Laboratory

WG 24 — SOFT FACTORS IN MILITARY MODELING AND ANALYSIS — Abstracts

Representing Physical Fatigue in Navy Combat Models

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Physical readiness is one important component of personnel combat readiness. Fatigue can be defined as a degradation in performance capabilities occurring as a natural consequence of task performance. Knowledge of their rate of fatigue and the effectiveness of countermeasures is important to realistically represent humans in combat modeling scenarios.

This session provides an overview of a physical fatigue model for physically demanding Navy tasks. Presentations will cover three specific areas:

a. Physiological Bases of Fatigue: Bioenergetics process will be considered to define the physiological bases of fatigue. Methods of modifying these processes (e.g., physical training, ergogenic aids) to reduce fatigue will be reviewed.

b. Ability and Performance: Models relating task performance to physical abilities will be reviewed, including the available evidence on physical demands of Navy tasks and the relationships between physical ability and task performance.

c. Work-Rest Models: Basic models for work-rest cycles and fatigue will be described. The concept of work capacity will be used to link individual readiness to task performance. Issues considered include representation of work capacity as an integrated ability measure, algorithms relating work capacity to task performance, and proper design of work-rest cycles to optimize performance.

Projecting Battlefield Casualties: Incorporating Socio-Cultural and Other Adversary-Specific Factors

Christopher Blood, Head, Operations Research Division
Daniel Rotblatt, Scientist I, GEO-Centers, Inc.
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The incidence of battle injuries among ground forces in a combat theater represents a factor that can potentially impact the success or failure of a military operation, and yet is not typically modeled in "traditional" or analyses. By fitting theoretical distributions to historical casualty admission data, information may be inferred from the underlying nature of these distribution which can then provide a basis for simulating future wounded-in-action (WIA) and killed-in-action (KIA) rates. A ground casualty projection system (FORECAS) has been developed to: 1) provide medical planners with estimates of the average daily rates of casualties that may be sustained in a given scenario, 2) indicate the maximum daily casualty loads that must be incurred and for which planning is necessary, and 3) enhance understanding of the statistical properties of WIA and KIA rates for use in future modeling efforts.

Current casualty forecasts are based on the empirical data of past operations, geographical theater considerations, and the composition of the deployment force. Also required for accurate casualty projections is the incorporation of adversary-specific factors into the FORECAS methodology. Cultural and societal factors which impact battlefield performance, and therefore potential casualties sustained, have been analyzed for inclusion within the FORECAS system. Demographic and military data available for potential adversaries were examined to determine their appropriatenessas indices of morale, latent ideology, and battlefield performance, and therefore potential casualties sustained, have been analyzed for inclusion within FORECAS system. Demographic and military data available for potential adversaries were examined to determine their appropriatenessas indices of morale, latent ideology, and potential impact of these factors on previously established casualty rates. Weapons parity between U.S. forces and potential adversaries were also examined and factored into the casualty projection algorithms.

"Sensitizing" Synthetic Forces to Environmental Stresses on the Virtual Battlefield

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Approved abstract not available at printing.

Using Fuzzy Logic to Model Human Behavior

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Approved abstract not available at printing.

Integration of U.S. Marine Air-Ground Task Force Tactical Warfare Simulation and the Medical Analysis Tool: Phase One

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In August 1995, under the direction of LCDR Sashin of the Joint Chiefs of Staff, J4-MRD, we gegan interfacing the U.S. marine Air-Ground Task Force Tactical Warfare Simulation (MTWS) and the Medical Analysis Tool (MAT). This first phase allows Wound In Action (WIA) numbers generated in MTWS to be read into MAT for each military unit simulated in MTWS. This flow of information creates a means of performing medical evacuation planning and training based on Marine military tactical planing and training. The work completed and follow-on plans will be discussed.

Breaking the OOTW Scenario Development Paradigm

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Operations Research Analysts have created a scenario

development paradigm that assumes the use of computer simulations to support scenario development and analysis. While it is true that the majority of scenarios are computer based, as well as being force on force engagements, Operations Other Than War (OOTW) scenarios provide a new challenge for analysts. The limited number of OOTW scenarios is a direct result of the difficulty in spplying computer technology to OOTW scenario development. Scenario developers successfully use the paradigm in OOTW scenarios involving combat operations. However, the paradigm fails in OOTW scenarios exercising combat support (CS) and combat service support (CSS). A TRADOC study involving refugee camp relief and disaster assistance posed new and interesting situations that currently available modeling technology could not simulate.

Because many aspects of refugee camp relief and disaster relief are difficult to model in computers, one of the original scenario methods, seminars with subject matter experts (SME), was revived as the scenario development tool. The complex and dynamic rules of engagement and rules of interaction required face-to-face communication. The effects of psychological operations and media pressure on the forces, the local population, the refugees, and the overall mission posed situations better portrayed by role players and facilititators. Using the seminar approach for an OOTW scenario proved extremely useful in developing and analyzing these and several other issues.

Navy Combat Leadership for Tomorrow: Where will we get such Men and Women?

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Analysis of need for combat leadership doctrine in the U.S. Navy. Reivw of existing literature with conclusion that current studies do not adequately address depth or breadth of topics that must be considered by Navy to properly assess how it will develop combat leaders in future. Analysis of series major issues integral to the development of combat leaders: (1), difference between combat and non-combat leadership; (2), variation in leadership requirements by rank and position; (3), are leadership requirements different in the U.S. Navy from those in any other Service?; (4), does leadership vary according to national and other cultural contexts?; (5), do leadership skills need to account for different cognitive preferences; and (6), do we need charismatic leaders? The report then goes on to assess the problems of developing combat leaders in an era of long peace. Specific improvements to existing methods of training combat leaders are then addressed. Finding, conclusions, and recommendations include: (1), the need for Navy combat leadership case studies; (2), the need for supporting research; (3), the development of a Navy combat leadership concept paper; (3) and the eventual development of Navy combat leadership doctrine. The fundamental place for combat leadership doctrine is as an integral element of combat power. Another major conclusion is that the Navy owes the individual Service member an opportunity to gorw and needs a personal growth element in its combat leadership development. Two additional "spin-off" dimensions are the need to assess the special requirements of combat leadership in a maneuver warfare environment and to assess the role of NDC as the learning organization for the Navy.

Design Considerations for Virtual Combat Medicine Trainers

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Operational environments are extremely rich sources of information. The tasks required for successful performance of military medicine in the operational environment superimpose yet another level of complexity on this training. In addition, medical decision-making and resource allocation is performed in a team environment, enabling further opportunities for leveraging individual skills and experience.

Virtual environments create a platform in which the users may be fully immersed in the anticipated field environment. In this way, realistic stressors, i.e. threat, terrain, auditory saturation, and marginal perceptual cues (reduced visual cues in night operations) may be overlaid on the patient scenario. Also, several users can train within a shared simulation, providing an opportunity to evaluate team coordination, communication, and situation awareness on team and individual levels. Hence, situational training involves a hierarchy of decision-making requirements within a specific environment (operational) or set of scenarios.

Situation or operational training in the virtual environment differs from other types of virtual reality based training in that: a greater level of detail is required; a broad range of scenarios and outcomes are possible (as would be expected in the real-world); and individual/team behaviors are less predictable. These characteristics are analogous to the requirements of the tactical environment, in which situation awareness and continuous assessment of the environment are as critical as patient management decision-making.

WG 25 — SOCIAL SCIENCE METHODS — Agenda

Chair: Dr. Jock Grynovicki, ARL
Cochairs: Annette Ensing, MITRE
Capt C. Cohen, MCCDC
Capt D. Bates, MCCDC
Gilbert Kuperman, Armstrong Lab
Hugh Dempsey, LMTF
LCDR J.K. Schmidt, NAS Norfolk
Michael Ingram, TRADOC Analysis Center
Advisor: Dr. James Geddie, ARL
Room: GIF, 357- A&C

Tuesday, 1030-1200
Functional Description of the Battlespace
Dr. Michael Baranick & Dr. Robert Wright & Mr. Doug Elam, Resource Consultants, Inc.

Modeling Judgment in the Analysis of Data
Dr. Barry Bodt, ASHPCD, ARL

Design of Experiments Applied to Prairie Warrior and Other AWEs
Cadet Robert Ewers & MAJ David Olwell & Cadet Nathaniel Peters, US Military Academy

Estimation of Energy Expenditure on the I-PORT Mobility Platform
Andrea Krausman, HRED, ARL

Tuesday, 1530-1700
Human-Centered C2 Modelling and Measurement for Army Battle Teams
Annette R. Ensing, MITRE Corp & Dr. Beverly Knapp & Joyce Johnson, ARL

Empirical and Analytical Methods for User-Centered Design: A Synergistic Approach for the Downsized Ground Control Station
Michael Barnes, ARL-Ft. Huachuca Field Element

Recent Technological Advances in the Quantitative Analysis of Historical Data on Combat Operations
Dr. Robert Helmbold, U.S. Army Concepts Analysis Agency

Empirical Based Testing of Command and Control Display Formats for THAAD
Dr. Richard Steinberg & Mark Curley & Chris Grounds, WJ Schafer Associates, Inc.

Wednesday, 0830-1000
Methodological Considerations of Investigating Soldier Performance During Sustained Operations
Linda Fatkin & Dr. Joseph Knapik & Dr. Madeline Swann & Teresa Treadwell, HRED, ARL

The Effects of Vehicular-Induced Vibration on Target Acquisition and Tracking Performance Using a Fixed Yoke with Thumb-Operated Tracking Control Versus a Displacement Yoke
Monica Glumm & Dr. Jock Grynovicki, HRED, ARL

Information Requirements Analyses for Battlespace Information Dominance
Gilbert G. Kuperman, Armstrong Lab, WPAFB

Wednesday, 1330-1500
Analytic Support to Battle Command Advanced Warfighting Experimentation
Michael Ingram, TRADOC Analysis Center

A Quick Response Approach to Improving and Assessing the Operational Performance of the XM93E1 Nuclear, Biological, and Chemical Reconnaissance System Through the Use of Modeling and Validation Testing
Richard McMahon, HRED, ARL

Performance Based Metrics for the Digitized Battlefield
Dr. Jock Grynovicki & Dr. Dennis Leedom & Michael Golden, HRED, ARL

Wednesday, 1515 - 1645
COMPOSITE GROUP VI SESSION .... GIF, Dupuy Auditorium

Thursday, 0830-1000
Ergonomics in Support of Military Operations
LTC Annette Sobel, USAF/Sandia National Laboratories

Modeling the Effects of Recoil of Shoulder-Fired Weapons on Body Dynamics
William Harper & Dr. Jock Grynovicki & Kathy Leiter & Sam Ortega & Kragg Kysor, HRED, ARL

Human Performance Measurement in Ballistic Missile Defense C2 Simulations
Dr. Beverly Knapp, ARL & Ms. Carol Daniel, Nichols Res Corp & Annette Ensing, MITRE Corp

Thursday, 1330-1500
Information Theory and Prioritization
Hugh Dempsey, OCSA Louisiana Maneuvers Task Force

The Optimal Placement of Casualty Evacuation Assets: A Linear Programming Model
Christopher Blood & Scott Sundrstrom, Naval Health Research Center

Detectability of Sounds Coming from Various Directions in Natural Environments
Tuyen Tran & Tomasz Letowski & Joel Kalb, HRED, ARL

WG 25 — SOCIAL SCIENCE METHODS — Abstracts

Functional Description of the Battlespace

Dr. Michael Baranick, Dr. Robert Wright, Mr. Doug Elam
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The Functional Description of the Battlespace (FDB) is a research and development effort managed by STRICOMÕs PM FAMSIM and the national Simulation Center to provide a distributed information repository to support the development and linking of DIS complaint constructive, virtual and live simulations. The primary objective of the program is to provide verified, validated and accredited data for model builders to create realistic simulations of the battlefield. A process for defining the data needs was created based on using the Mission, Enemy, Terrain, Time and Troops available (METT-T) as the starting point. The Training Requirements Prioritization Index (TRIP) methodology used to prioritize the training tasks as well as the processes used for data collection, data verification and data base population are described. The paper also discusses how the modeler can access and use the data base.

Modeling Judgment in the Analysis of Data

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One component in the assessment of the performance of an armor configuration is to evaluate the damage potential of behind armor debris when the armor is defeated. A low resolution description, often used at a screening test level, involves a conceptual right circular cone that contains the main portion of the fragment spray. The principal axis of the cone can be determined objectively but the judgment of only a few analysts is relied upon to fix a cone angle which best summarizes the main portion of the fragment spray. Judgment is used to exclude fragments that are extreme or unusual relative to the main cloud and is rooted in a deep understanding of the damaging potential of fragments. This understanding has been gained from years of working with vulnerability models and examining the results of testing. Such assessments take time and the experienced analysts who make them will not always be there to do it.

The thrust of this work was to model the subjective manner in which the spall cone is established so that analyses could be made more quickly and so that corporate memory could be preserved. A representative sample of data sets were examined by analysts and spall cones were established. A statistical test for outliers was formulated as a sequential process and the parameters of that process were adjusted to provide a good fit with the subjective decisions of the analysts.

Design of Experiments Applied to Prairie Warrior and other AWEs

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Is it possible to make valid statistical inferences based on AWEs? Current practice does not seem to include randomization, blinding, controls, or replication. Inference based on AWEs is, accordingly, subjective at best. The authors report on the results of consulting work they did for the Army Research LaboratoryÕs Human Research and Engineering Directorate to improve the design of AWEs. In their paper, the authors examine a design which works within the existing Prairie Warrior framework, yet allows for replication, randomization, controls, and blinding. The authors report on their experience applying portions of their design to Prairie Warrior 96 and their initial results. They further advocate that fundamentals of design of experiments be extended to all facets of AWEs.

Estimation of Energy Expenditure on the I-PORT Mobility Platform

Ms. Andrea Krausman and Dr. Joe Knapik
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Modern simulation technology has proved to be a fundamental element in maintaining readiness for war since it provides soldiers with skills and techniques that are transferable to battlefield conditions. One of the most recent developments in simulation technology to aid the infantry soldier is the I-PORT or "Individual Portal". The I-PORT consists of (1) a mobility platform which allows soldiers to maneuver their way through a virtual environment, (2) a model M-16 rifle, and (3) a helmet-mounted display through which the soldiers see the terrain and environment. Kinesthesia, providing for a person's sense of moving and performing work, will be one major determinant of credibility of the I-PORT device. To make the I-PORT device fully realistic, it will be necessary for physical exertion, experienced by the user, to be similar to that felt during an actual situation. For example, if the situation requires climbing a hill, the user should experience an increase in energy expenditure that equates with the uphill grade. The major objective of this research is to determine the energy expenditure associated with the I-PORT device. An Oxylog[R] device will be used to measure energy expenditure. The actual energy expenditure will be compared to a validated predictive formula that uses the subject's weight, speed, grade, load, and terrain type. Grades will include -5.0, -2.5, 0, 2.5, and 5.0 and all subjects will serve in all conditions. A Wilcoxon matched-pairs signed-ranks test will be used for data analysis although more appropriate statistical techniques may be available.

Human-Centered C2 Modelling and Measurement for Army Battle Teams

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The next generation of C2 (Command and Control) concepts, C2 vehicles, and advances in computer and communication technology provide the Army with the elements to significantly enhance C2 Team performance on the battlefield, while potentially decreasing personnel. Finding the right tactics, organization, soldier-machine interface, personnel, and training needed to maximize the utility of the next generation C2 environment is a major challenge. Modelling and measuring C2 accurately has been a difficult problem, because: conventional task analysis methods are not well suited for the complex, continuous, non-sequential, primarily cognitive tasks characteristic of C2; and, most models deal with C2 communications and omit human processing.

This paper describes a method for modelling and evaluating C2 tasks and workload, to optimize manpower allocation and systems designs, using human process-oriented data collections and syntheses to determine how information flows through the C2 system, and how it impacts the tasks performed. Information ÒeventsÓ are the incoming transformed data which trigger detailed task processes performed by the operators. Techniques were developed for decomposing decision tasks for both individuals and groups. An existing networking and resource allocation analysis tool was adapted to model and measure mental task demands and timelines. An analysis framework, developed to both isolate and combine the many C2 variables of interest, permitted a variety of Òwhat ifÓ excursions (e.g., noise, communication delays, new software, distributed operations). Although developed for Army C2 at a tactical level, the method appears robust and applicable for any C2 center.

Empirical and Analytical Methods for User-Centered Design: A Synergistic Approach for the Downsized Ground Control Station (DGCS)

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The DGCS for maneuver versions of the unmanned aerial vehicle (UAV) offered a unique challenge to demonstrate new methods for user-centered design. The host air vehicle was not yet designed. There was a requirement for a single operator to replace two-man crews for some applications and the display and control space had been radically reduced from the current GCS.

Too often, the user-centered approach consists solely of including potential users as part of the design team--an approach with limited ability to investigate creative design options. This paper documents a synergistic methodology that uses (in concert) crew modeling, laboratory experiments, and crew simulations. The limitations and advantages of each of these are discussed. HARDMAN III models allowed us to understand the crew's workload environment and examine various automation options. Laboratory experiments were used to help choose the display characteristics as well as to decide among various control options. Crew performance for candidate DGCS concepts was investigated with 16 trained operators during a series of 72-hour flight simulations.

The results complemented each other and overcame the limitations of the individual methods. For example, the simulation studies were used to expand and verify the modeling efforts, whereas the laboratory experiments were used to delimit the options investigated in the more expensive 72-hour exercises. An important advantage of the simulations was that it allowed potential users to make informed design recommendations regarding new concepts. Finally, the paper discusses various automation options resulting from the methodology and reveals future plans to expand the methodology to field exercises at Ft. Hood.

Recent Technological Advances in the Quantitative Analysis of Historical Data on Combat Operations

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From time immemorial, efforts have been made to extract meaningful information from the historical records on combat operations. Most of these efforts have attempted to use informal and qualitative approaches to this difficult subject, but without much notable success. Recently the U.S. ArmyÕs Concepts Analysis Agency (CAA), has taken a rather different approach--one distinguished by an emphasis on quantitative techniques, and the application of systematic scientific methods to a collection of large and trustworthy data bases.

Several major advances in the state of the art have been achieved by this approach. This presentation will focus on these major new insights into the characteristics and dynamics of combat, and its dynamics. The major historical studies undertaken by CAA will be summarized. Their key results will be presented, and the importance of these results to military analysts as well as their implications for the military commanders will be identified.

Empirical Based Testing of Command and Control Display Formats for THAAD

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As computer graphics workstations continue to increase in the ability to display more information, the necessity for an intuitive Graphics User Interface (GUI) becomes paramount. The ArmyÕs THAAD program is pioneering research in Human Computer Interaction for Command and Control Displays. Advances in computer technologies create a challenge for THAAD GUI designers to display information in a manner which will augment an operatorÕs decision making capability without causing information overload. Previous real-time GUIs for DOD applications have been designed using style guides based on industry standards for commercial products. Typically this GUI design and implementation has been driven by user preference rather than optimizing performance. Research has shown that users do not necessarily prefer the GUI that best supports their performance. Military operations demand that real-time Command and Control displays be based on user performance to insure mission success.

Experimental Command and Control formats currently being developed by the ArmyÕs THAAD program are being tested with soldiers at Fort Bliss, Texas. Testing involves gathering operator performance based data, response times and error rates. Through the use of empirical based experiments, recommendations for the Graphic User Interface designs may be made based on operator performance rather than personal preference and existing style guides. Incorporation of this research into the next generation of DOD Command and Control displays will enhance the ability of the soldier/operator to save the lives of civilians and other soldiers during military operations.

The Effects of Sustained Operations on Female Soldier Performance: Methodological Considerations

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While the use of continuous work periods has become important to the functioning of the civilian sector (i.e., medical services, fire fighting, etc.), it has become paramount in conducting military operations. Technological advances in equipment, doctrinal changes, broadened mission requirements, and budgetary constraints have extended soldier performance demands and operational duration. A small armed force deployed to various warfighting, peacekeeping, and humanitarian scenarios may require sustained work periods for pre-deployment, deployment, insertion, mission propagation, and completion phases. Therefore, it is imperative to examine how soldier performance can be predicted and maintained during sustained operations in various occupational specialties.

Because of previous restrictions that kept women from combat arms occupations, data are minimal regarding female soldier performance in field operations during extended periods. This research project was funded by the Defense WomenÕs Health Research Program to examine the effect of sleep deprivation using standardization psychological, cognitive, and physiological tests administered every 4 hours during a 48-hour sustained operations period. The soldiers, all assigned to the 180th Transportation Battalion combat support unit, were also evaluated by senior NCOs to access soldier performance. Twenty-six soldiers, 13 female and 13 male, participated in the study. The objectives were to compare the effects of sustained operations and circadian rhythms between male and female soldiers in a field environment and to assess soldier performance efficacy (e.g., common soldier tasks, heavy vehicle maneuvers, sniper training) necessary to operate in the modern battlefield. The methodology and results of this evaluation are presented in this paper.

The Effects of Vehicular-Induced Vibration on Target Acquisition and Tracking Performance Using a Fixed Yoke with Thumb-Operated Tracking Control Versus a Displacement Yoke

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This paper describes the methodology and results of a study designed to quantify the effects of vehicular-induced vibration on tank gunner performance using two different types of control handles. One control was a fixed yoke that incorporated a force-sensitive thumb button which was used to position the gunner's cross hairs on target. The second control was a displacement yoke which functioned like that in the current M1A1 tank.

The study was conducted on a ride motion simulator capable of providing the pitch, roll, and yaw of a tracked vehicle. For this study, the simulator was programmed to reproduce rides imparted to the gunner in an M1 tank traveling at various speeds over courses at Aberdeen Proving Ground, MD. During the study, 30 armor crewmen, wearing the standard combat vehicle crewman's gloves, performed target acquisition and tracking tasks in a stationary or no-motion condition, and at four levels of ride which ranged from "mild" to "severe.Ó Fifteen of the 30 subjects performed the target acquisition and tracking tasks using the fixed yoke with force-sensitive thumb button and another 15 subjects performed the same tasks using the displacement yoke. During the study, the subjects were presented both stationary and moving targets. Measures of performance included time from target presentation to trigger pull, time on target, lay error at trigger pull, and the percentage of target hits to trigger pulls. The average frequency, amplitude, and watts absorbed power imparted to the subjects were computed from the time a target was presented to the time of first trigger pull and for the periods between subsequent trigger pulls.

The performance data were analyzed using principle component and regression techniques. The linear quadratic and cubic effect of vibration and hand control on gunner performance was quantified.

Information Requirements Analyses for Battlespace Information Dominance

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"Information Warfare" (IW) is emerging (along with Air and Space Warfare) as the third pillar of the Air Force's basic doctrine. The objective is to support the joint warfighter in achieving and exploiting dominant battlespace awareness.

Conventional mission decomposition tools (e.g., task/timeline analysis) are inadequate to support this objective since they focus exclusively on the actions and time requirements of the task and do not reflect the informational needs of the warfighter. Cognitive engineering tools offer promise to overcome these deficiencies. This paper explores the Air ForceÕs definition of IW and presents current research in cognitive psychology applied to the IW mission area.

Dominant battlespace awareness may be achieved by gettingÓ the right information to the right warfighter at the right time.Ó One approach to achieving this is based on Common Battlespace Display (CBD) systems. Information requirements analyses are needed to support the design, development and employment of CBDs. The Observe-Orient-Decide-Act (OODA) loop model has been widely accepted by the IW community for the representation of domain expertise. Research to date has been almost totally on the decision making component. The Observe (exploitation of battlespace sensor systems) and the Orient (achievement and maintenance of situational awareness) components can be enhanced through the application of cognitive engineering tools and methods. Storyboarding, exploiting operational effectiveness models, has been demonstrated to be effective in identifying critical decision events distributed across a theaterwide battlespace. Fuzzy set theory applications are being explored to quantify the accrual and integration of battlespace information of uncertain accuracy, latency, and/or completeness. Cognitive mapping supports the analyst in eliciting and depicting domain expertise as regards to situation assessment, the evocation of possible behaviors, and the expected effectiveness of alternative actions. An ÒOODA loop of OODA loopsÓ has been used to capture the Òsystem of systemsÓ theater warfighting architecture. The OODA ÒspiralÓ has been used to capture the dynamic nature of changing priorities and task objectives.

Analytic Support to Battle Command Advanced Warfighting Experimentation

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This paper briefly describes the primary efforts of the U.S. Army Training and Doctrine Command (TRADOC) Analysis Center (TRAC) to support the U.S. Army Battle Command Battle Laboratory (BCBL) Advanced Warfighting Experiments (AWE) in 1994, 1995, and 1996. Analytic support efforts in this environment have relied upon a set of tools other than the usual modeling and simulation, although simulation exercises (SIMEXs) are the main experimentation events. During each of these years, the BCBL used students in an elective class of the Fort LeavenworthÕs Command and General Staff Officer CourseÕs (CGSOC) Battle Command Elective (BCE) as the vehicle for experimentation. This elective grew in three years from 28 to 73 to 89 participants. Each year, this class formed the core of the command and staff of the Mobile Strike Force (MSF), a notional experimental unit for Force XXI development. Each year, the BCE culminated its effort by fighting, augmented with additional CGSOC students, as the MSF in the CGSOC Prairie Warrior (PW) Exercise.

The approach taken to analytically support the BCBL

evolved to one in which the TRAC study team totally integrated with the BCE in 1995 and 1996. The team attended all BCE classes, seminars, guest speaker sessions, tactics, techniques, and procedures (TTP) development sessions, SIMEXs, and after action reviews. This enabled accomplishment of comprehensive data collection plans which always include literature review, review of prior AWE results, observation of all BCE activities, and administration of student surveys. The surveys are the tool upon which many of the key insights from the AWEs are either initially developed or further explored. This paper will focus on how statistical analysis of student surveys, and observations of BCE activities were combined to address Force XXI battle command issues.

A Quick Response Approach to Improving & Assessing the Operational Performance of the XM93E1 Nuclear, Biological, and Chemical Reconnaissance System (NBCRS) Through the Use of Modeling and Validation Testing

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With a Milestone Decision Review just months away, the XM93E1 NBCRS received an operational assessment of ÒunsuitableÓ because crew work load had reduced mission performance to unacceptable levels. The U.S. Army Research Laboratory (ARL) assisted the NBCRS product manager by identifying system modifications to reduce crew work load and estimating the expected value added by these modifications. The NBCRS test integration working group also responded with a unique operational test methodology which was quick, low cost, and allowed for a comprehensive operational assessment of the modified system.

This effort combined ARL human figure modeling and hardware versus manpower (HARDMAN) IIII modeling with operational validation testing. The HARDMAN III model predicted that the system design improvements reduced mission performance time by 12% because crew work load for mission-critical tasks was reduced. With this indicator of success in hand and using the modeling to help focus the planned testing, the TIWG developed what was termed an Òoperational MANPRINT validationÓ (OMV) test, which concentrated on the key mission performance characteristics identified by the modeling effort.

This model and validation test approach provided for a comprehensive operational assessment of the NBCRS with minimal funding and time requirements. The total time from initial model development to receipt of draft operational assessment was 5 months. Data collected during the OMV are being used by ARL to update and accredit the HARDMAN III model for future use.

Performance Based Metrics for the Digitized Battlefield

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The Force XXI concept lays the foundation for the 21st Century Army that is digitized and redesigned to achieve land dominance. Digitization supports the acquisition, exchange, and use of information in order to create and maintain a common relevant picture of the battlefield. An integral link to achieving this goal is assuring that the soldier can effectively operate in a highly technical battlefield and integrate with the digital subsystems. To achieve this goal, the Army needs standard measures of soldier performance for information processing and decision-making tasks.

This paper describes an anchor scale methodology and standardized task performance metrics for evaluating integrated soldier information system performance at the Tactical Operation Center. These metrics have been accepted by TEXCOM and have been used to gather subjective data. The basic quality areas addressed are mission planning and refinement, information assimilation, generation and transmittal of messages and reports, situational awareness, workload distribution, monitoring and receiving critical messages or events.

These metrics provide both technology developers and field users with a common, standard framework for defining and evaluating performance. Results from an Advanced Warfighting Experiment (AWE) training exercise will be presented.

Ergonomics in Support of Military Operations

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The operational environment poses many opportunities for evaluation of Òsoldier interfacesÓ which may impact performance. For example, the pilot-cockpit interface, the special operator-personal protective gear/vehicle/parachute interface, and the medic-life-support equipment-patient-transport platform interface, to name a few. Quantitative metrics, and validation capabilities for prototype systems are essential to demonstrating field utility, operator acceptance, and smooth transition to the operational community.

Extension of DataSuit and DataGlove technology (described in this talk) to creation of accurate, reliable, and reproducible test environments is one solution. Application of this technology will provide the capability for measurement of full-body, full-articulated motion in an unencumbered user environment. Human-system performance unbiased by physical constraints of the sensors may be thoroughly evaluated through a range of training scenarios. In this way, opportunities for re-engineering may be defined in the front-end of program development, and improved performance may be achieved incrementally and through objective data.

Modeling the Effects of Recoil of Shoulder-Fired Weapons on Body Dynamics

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The Human Research and Engineering Directorate (HRED) of the U.S. Army Research Laboratory conducted a study to determine and model the effects of firing high recoil weapons on the body dynamics of the soldier firing the weapon. This study was a follow-on to a HRED study funded by the Joint Services Small Arms Program (JSSAP) office.

This research effort was designed to examine and model how the body and weapon move when weapons with high levels of recoil energy and recoil velocity are fired. The testing was designed around standard commercially available 12-gauge shotgun ammunition and instrumented 12-gauge shotguns chambered for firing the standard 3-inch magnum cartridge. Incremental magnitudes of recoil impulse were achieved by selecting specific loads. Incremental magnitudes of recoil velocity and recoil energy were produced by modifying the weight of the shotguns. This resulted in six unique recoil energy-velocity levels with a recoil level of 18 ft-lb of energy and with 11 ft/s velocity chosen as the baseline.

A total of 16 soldiers participated in the study. Nine anthropometric measurements were made on each of the subjects. These measures included weight, stature, submandible height, trochanter height, trunk length, acromion-radiale length, radiale-stylion length, chest depth, and chest circumference. Each subject was required to fire the baseline weapon one time and each of the test weapons twice in a random order. Weapon and body displacement was recorded using a video-based system (Motion Analysis Corporation, Santa Rosa, California).

Principal Component Analysis was used to select a subset of the anthropometric and physical characteristics of the weapon and their linear, quadratic, and cubic components that correlated with weapon, shoulder or cheek displacement. Stepwise Regression was then used to select the ÒbestÓ possible regression equation. The final result is three models that predict weapon, cheek and shoulder displacement.

Human Performance Measurement in Ballistic Missile Defense C2 Simulations

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Future Ballistic Missile Defense (BMD) command and control (C2) command and operations centers are being simulated in large scale hardware and software testbed environments (e.g., National Test Facility, Colorado Springs, CO) to assess new BMD operations concepts (CONOPS). Key simulation questions are, what are optimal commander and staff roles and responsibilities in missile warning and engagement centers, and does C2 information flow within and among these centers to effectively support decision-making? Until recently, immediate player feedback was the primary method of determining C2 efficacy, since early simulation efforts were most concerned with building the realistic BMD C2 operational environment.

The BMD C2 community has begun in earnest to integrate performance-based measurement and analysis into the C2 simulation process by introducing a systematic approach for evaluating individual and crew decision tasks during more controlled scenario-event conditions. This measurement strategy includes real-time direct behavioral observation techniques, automated data recording, player information and workload scaling instruments, and content analysis of player actions and commentary. Data from several successive simulations have now allowed the formulation of BMD C2 performance baselines and CONOPS excursions during varying information flow conditions. One promising technique for performance comparisons involves creating comprehensive operational sequence diagrams (OSDs) showing scenario events and player actions in a timeline diagram. The OSD and supporting information use data allow quantitative comparisons of C2 CONOPS and provide an empirical basis to substantiate information and decision interface designs.

Information Theory and Prioritization

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A frequent task in the Army is to prioritize a list of items. Prioritization is always a difficult task, but in the Army it is almost always complicated by the need to accommodate group input into the prioritization process. This is, of course, vital as the interests of all interested parties must be addressed, but it does make a hard problem harder. Some of the processes used are ordinal numbering and weighted voting; both are lacking.

In an ordinal numbering process, the members each list all of the options in their preferred priority listing, e.g., 1. FAMAS, 2. RPV, 3. M1A3 Tank,... The problem is that there is minimal information regarding the quantity of interest a person puts on a given item. One might consider FAMAS to be twice as important as the RPV, while considering the RPV to be only slightly more important than the M1A3 Tank. But this information is not included in an ordinal list.

In the weighted voting process, each committee member is allocated a given number of votes, which he may allocate as desired among the various projects. Now when totaling the votes, the referee has a sense of the relative importance assigned a project by a member. But there is no sense of relative weighting between committee members.

I propose to use Information Theory to address the prioritization problem. The method will be to allocate a number of votes to each member and to allow him to assign his votes as desired to each project. From this, the referee can construct an information entropy matrix of voter versus project. The projects will then be ranked in order of highest information entropy; this rank ordering will be the prioritization listing.

The Optimal Placement of Casualty Evacuation Assets: A Linear Programming Model

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Combat casualties in a theater of operations are treated at mobile medical facilities organized into a series of echelons with the facilities at the forward echelons having the greatest mobility but least surgical capability. The efficient evacuation of casualties from echelon to echelon is essential to ensure the wounded personnel reach a facility with the capability to render the required level of care. Distances between medical treatment facilities, as well as factors such as the type of terrain and mode of transportation, may all impact the evacuation process. Likewise, the number of treatment facilities deployed and where they are located greatly affects the casualty handling process and the ability to provide adequate casualty care.

The focus of this endeavor is the selection and development of an appropriate linear programming technique which will allow optimization of the number and positioning of evacuation assets at given treatment facilities in a theater of operations. Because inter-theater evacuation of patients is handled for all services by the U.S. Transportation Command (TRANSCOM), the present effort focuses on intra-theater casualty evacuation -- transporting wounded Marines from the point of injury, through Echelons I and II in the combat zone, and ending at an Echelon III level of care (e.g., Fleet Hospital). The methodology developed will be flexible enough to allow incorporation of treatment facilities and evacuation assets of other service branches within the combat zone, particularly those of the Army which may very well have forces interdeployed with the Marines. The optimization model will require data on patient flows, troop strengths and deployment locations, terrain, size of theater, numbers and types of ground/air ambulances available, types and locations of Echelon II and Echelon III treatment facilities, and length of evacuation delay. Using this input, the planning tool will compute the optimum numbers, types, and deployment coordinates of the evacuation assets, including ambulance exchange points.

Detectability of Sounds Coming from Various Directions in Natural Environments

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Detectability of acoustic signals depends on the direction of the incoming sound. This dependence has to be included in the auditory detection model which was developed to predict the detectability of sounds in natural environments. Twelve subjects participated in a study involving detection of acoustic signals coming from 9 loudspeakers located in the same horizontal plane and equally spaced within - 90 to + 90 degree azimuth. All loudspeakers were located 1m from the subject's head. The acoustic sounds consisted of nine puretones and five complex environmental sounds. The sounds were presented in quiet and in a background of 80 dB pink noise. The results of this study will benefit the development of future auditory detection models. They may also serve as a limited database for the development of a new standard for sound field audiometry.

WG 26 — LOGISTICS— Agenda
Chair: Alan Cunnigham, US Army TRADOC Analysis Center--Fort Lee
Cochair: CPT Scott Schutzmeister, US Army Materiel Systems Analysis Activity
Advisor: Clarke Fox, US Army Materiel Systems Analysis Activity
Room: GIF, 359-A

Tuesday, 1030-1200
Dyna-Metric modeling: Representation of Army-Wide Supply, Transportation, and Maintenance System for High-Technology Components
Erik Tollefson, US Army TRADOC Analysis Center - Fort Lee

Two Levels of Maintenance: Methodology for Cost-Benefit Analysis for USAF fighter Avionics
CPT(P) Dennis R. Benson, Air Force Logistics Management Agency

Tuesday, 1530-1700
Demand Variability - A Historical Overview and Actions that DLA has Initiated to Maximize Inventory Dollar Investments
Thomas Lanagan, DLA Operations Research Office

Application of Censored Data Concepts to Estimation of Repair Part Demand Variance
Eric A. Snyder, US Army Materiel Systems Analysis Activity

Wednesday, 0830-1000
Logistical Representation in Vector-In-Commander
MAJ Michael L. Boller, Richard Cunningham, Scott Cox, US Army TRADOC Analysis Center - Fort Leavenworth

Joint Advanced Strike Technology/Joint Strike Fighter (JAST/JSF) Logistics Modeling Environment (JLME)
John Schneider, Dynamics Research Corporation

An Architecture for Logistics Planning
Miranda Moore, US Army Logistics Integration Agency

Wednesday, 1330-1500
Reconstitution of Army Combat Service Support Units Engaged in OOTW
James Behne, US Army TRADOC Analysis Center - Fort Lee

Personal Computer Optimum Stockage Requirements Analysis Program (PC-OSRAP)
Ruth S. Dumer, US Army Materiel Systems Analysis Activity

Automating Force Logistics Requirements Estimates
Alexander B. Blair, and Robert Miller, USACASCOM&FL

Wednesday, 1515 - 1645
COMPOSITE GROUP VI SESSION .... GIF, Dupuy Auditorium

Thursday, 0830-1000
A DLA Study on the Costs of Reducing Depot Processing and Transportation Time
Charles Myers, Benedict C. Roberts, DLA Operations Research Office

Defining, Measuring, and Predicting Productivity Gains Resulting from Logistics Management Automation
Conrad W. Strack, The Analytical Sciences Corporation (TASC)

Port Construction Study
CPT Michael Baisden, US Army TRADOC Analysis Center - Fort Lee

Thursday, 1330-1500
A Strategic Overview of the DLA Customer Sampling Plan
H.J. Kostanski, DLA Operations Research Office

Fleet Age Recapitalization
MAJ Peter A. Davidson, Andrew Kourkoutis, US Army Concepts Analysis Agency

Tuesday, 1030-1200

DYNA-METRIC Modeling: Representation of Army-wide Supply, Transportation and Maintenance System for High Technology Components

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The Dyna-METRIC model, version 6.3, developed by RAND Corporation, is being used to determine availability levels of weapon systems in a two MRC, near simultaneous TRAC scenario. As input, the model represents LRU and Shop Replaceable Unit (SRU) failures for variable operational tempos, mechanics and test equipment available to service the LRUs and SRUs at three echelons of maintenance, delays due to testing and/or repair of the LRUs and SRUs, stockage of "pipeline" EO spares available in the theater and in CONUS facilities, and transportation/administrative delays moving LRUs and SRUs between maintenance and supply nodes. As output, Dyna-METRIC determines at each moment in the scenario the number of weapon systems not Fully Mission Capable (FMC) due to EO RAM failures; that is, weapon systems which are "down" either because mechanics or testers are busy or because an EO spare is not available.

Dyna-METRIC predicts the availability of weapon systems at multiple units located in multiple theaters, given a planned operating scenario. To assess the effect of changes in the logistics support system on the weapon systems availability, it models the weapon system components, along with specified changes in the logistics support structure.

Two Levels of Maintenance: Methodology for Cost-Benefit Analysis for USAF Fighter Avionics

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Approved abstract not available at printing.

Tuesday, 1530-1700

Demand Variability -- An Historical Overview and Actions that DLA has Initiated to Maximize Inventory Dollar Investments

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Historically, inventory models have traditionally presumed that demand rates have been constant. This analysis examines that assumption from the wholesale perspective by assessing DLA business activity over an extended multi-year time horizon. The review spans the years of the Defense buildup during the Reagan Presidency through the end of the Cold War to include the initial force reductions of the 1990s.

This variability in demand, along with the force drawdowns of the current decade, has resulted in the Agency taking several initiatives to assure that DLA continues to meet customer demands while we collectively reduce overall Defense inventory investments. Initiatives have included "eating down" the so-called "iron mountains" and putting in-place aggressive programs to accelerate inventory trends since the standard "legacy" information systems all have a tendency to lag system behavior. Consequently, DLA has pursued new ground targeted to reduce both inventory and the order cycle time, and still get the right materiel out to the ultimate customer in the shortest possible time.

One of these key initiatives which will be addressed in some detail will focus on the Navy ship decommissioning program. DLA has worked closely with the Navy to maximize "real" savings under this program. Since SAMMS, the Agency's materiel management system, will lag the "real" system, there is a potential to expedite dollar savings related to inventory by fully accounting for fundamental shifts (in this case downwards) in the demand requirements. Consequently, money that has been "saved" from not investing in materiel for the decommissioned ships has been made available to support other systems.

Application of Censored Data Concepts to Estimation of Repair Part Demand Variance

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One of the input parameters needed in the application of requirements models is the percent error table. The percent error is a statistical measure used in determining the expected accuracy of a forecasting model. This error is defined as the percent difference between the observed and forecast demands.

Accurate estimates of percent error are need in the development of safety levels in controlling inventory. In determining percent errors, a question arises as to what is an acceptable level of error to attribute to a single forecast. This report deals with a methodology which determines a truncation point to handle large percent error outliers.

Since different truncation points, especially for low frequency parts, can greatly influence the observed percent error, a methodology has been developed which decides for a chosen frequency level a logical truncation point based on the fact that demands typically follow a negative binomial distribution. This methodology consists of a 5-step iterative approach which converges to the desired truncation point and associated percent error, while correcting for the fact that the errors are being censored.

Wednesday, 0830-1000

Logistical Representation in Vector-In-Commander

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We must evaluate Force XXI combat service support (CSS) operational concepts and force structure on a sound analytical foundation. Vector-In-Commander (VIC) is the Army's premier corps-level combat development simulation and study tool. Over the past 12 months, we have made enhancements to the VIC logistics module. These enhancements to the functionality of this module will greatly improve the Army's ability to address logistics study issues from company through corps.

This paper addresses several of the changes and enhancements that we have made: lapsing of supplies, predictive logistics, a "VIC Checker" to check for errors, output analysis, preprocessing of road networks, and a program for determining supply point stockage levels. Key enhancements currently in progress are: TBM effects on supply flow, ship scheduling per queuing theory, and TBM effects on Early Entry scenarios.

Joint Advanced Strike Technology/Joint Strike Fighter (JAST/JSF) Logistics Modeling Environment (JLME)

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Approved abstract not available at printing.

An Architecture for Logistics Replanning

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With the streamlining of our nations economy, many organizations, both large and small, are realizing the importance of using existing models and simulations in their analysis. Much time, money and research is going into building distributed architectures that connect existing systems and use their results to build a comprehensive plan. The limitations of such a system is that the existing systems they rely on are already developed and not always designed to be reactive, easy to change, or efficient to execute. A change to the plan could be costly and inefficient given that the only way to react is to change model parameters and re-execute. Little research, however, has gone into the replanning that is associated when changes are introduced into the system after the plan is built. Without this replanning capability, the planning system is not complete.

The paper to be submitted to MORSS describes a new architecture based on precepts from the field of Artificial Intelligence (AI) to be used for replanning in a distributed environment with an existing planning architecture. The existing planner is assumed to use one or more existing models that are connected through a networked, interactive architecture to build an initial plan. The replanner will react to plan changes that are required by user input, discovery of new goals, parameter changes, or other causes. Most current planners do not have the capability to do replanning. The proposed replanning system will have the ability to alter a previously defined plan to achieve a new goal state. When several distributed models are cooperating to build a plan, it is not always easy, efficient, or even possible to replan by changing the system parameters and executing the system again. Replanning in a dynamic environment requires a reactive and responsive replanning methodology. The architecture is a flexible, modular, decentralized one that can meet the changing needs of a distributed planning system. Transportation and redistribution problems associated with the ship cargo configurations exemplify the replanning concepts.

Wednesday, 1330-1500

Reconstitution of Army Combat Service Support (CSS) Units Engaged in Operations Other Than War

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The US National Military Strategy requires the US Army to support Operations Other Than War (OOTW) which involve missions such as humanitarian relief, peace keeping, etc., while remaining prepared to fight and win in two nearly simultaneous major regional contingencies (MRCs). Given the unique nature of the type of support required, a large number of the Army's Combat Service Support (CSS) units is often committed to OOTWs. Consequently, active duty Army CSS units must bear the burden of OOTWs while remaining trained and equipped for rapid deployment to two nearly simultaneous MRCs.

This analysis serves as a compendium and resource tool for analysts throughout the Department of Defense (DOD) community who are examining Army OOTW operations. It focuses on abstracting a large number of past and ongoing DOD/contractor studies, each of which examines one or more aspects unique to the use of Army CSS (and also Combat and Combat Support) units in OOTW. All studies were synthesized in relationship to their coverage of 14 different "Areas of Interest" specifically established for this review. These areas are: Mobilization; Deployment; Operational Employment; Reconstitution of Active Duty Army Units; Reconstitution of Army Reserve Units; Redeployment from OOTWs to a MRC; Backfill of CSS Units Leaving OOTWs; Strategic Lift Requirements; Presidential Selective Reserve Callup; Cost; International Law; Two Nearly Simultaneous MRCs; Risks to the Gaining MRC Commander; and Transitioning from one OOTW to another.

The study recommends as a minimum the framework for conducting future quantitative reviews for ascertaining if the US has enough Army CSS units to adequately support its National Military Strategy.

Personal Computer Optimum Stockage Requirements Analysis Program (PC-OSRAP)

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The Army Materiel Systems Analysis Activity (AMSAA) has developed stock optimization methodologies to support various ASL/PLL planning scenarios. The Readiness Based Sparing Model (RBS) provides Authorized Stockage Lists (ASL) in a peacetime environment . RBS uses historical unit demand data and optimizes on cost to provide requirements objectives for Class IX items. The Optimum Stockage Requirements Analysis Program (OSRAP) provides requirements objectives for Class IX items in support of wartime/contingency planning. The OSRAP uses the Candidate Item File (CIF) developed by the Major Subordinate Commands (MSCs) and combat damage data from the Sustainability Predictions for Army Spare Components Requirements for Combat (SPARC) as input to the model.

The PC-OSRAP was designed to enable the distribution of the mainframe FORTRAN programs, OSRAP and RBS, to PC users. PC-OSRAP uses object oriented programming tools, in the form of a graphical user interface (GUI) , to provide a user friendly model that incorporates both methodologies to determine optimum stock lists.

PC-OSRAP was written with Visual Basic 3.0, in the Windows 3.1 environment. It has multi-media applications, to include, Bit Map Pictures (BMP), sound or .WAV files, in-screen video, .AGI files, database access to DBASE III, DBASE IV, and ACCESS files. Most of the features of PC-OSRAP was accomplished with the tools included in Professional series of Visual Basic 3.0 with a few add-on VBX routines. The optimizing methodology routines were written in FORTRAN and complied for the PC. These files are accessed via a windows handler and a SHELL command.

Automating Force Logistics Requirements Estimates

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The US Army Combined Arms Support Command, Fort Lee, Virginia, has developed and released for general use a new program for computing the estimated consumption for supply classes I, Iw, II, III, IV, V, VI, VIII and mail. The program, named OPLOGPLN '96, is designed specifically to support apparitions typically associated with multi-phase operation plans and operation orders. The user creates UNITS based on standard Tables of Organization and Equipment (TOE) and maps these units into TASK ORGANIZATIONS. The TASK ORGANIZATIONS can then be assigned to a multi-phase ORDER and assigned user-developed MISSION PARAMETER SETS (which essentially describe the conditions under which the TASK ORGANIZATION OPERATES). Reports can then provide supply consumption by UNIT, by TASK ORGANIZATION, by PHASE, and by ORDER. OPLOGPLN '96 is an authorized product of the CASCOM containing the latest Department of the Army approved planning factors. CASCOM, on behalf of Commander, TRADOC, is the agent for the ODCSLOG for Army logistics planning factors as specified in AR 700-8. Data in OPLOGPLN '96 are valid through 31 Dec 96 unless sooner rescinded.

Wednesday, 1515 - 1645
COMPOSITE GROUP VI SESSION
GIF, Dupuy Auditorium

Thursday, 0830-1000
A DLA Study on the Costs of Reducing Depot Processing and Transportation Time

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Phone: (804)-279-3812;DSN: 695-3812

Every inch taken off of the logistics pipeline is known to result in reduced customer inventories; and therefore, reduced costs to the taxpayer. The Defense Logistics Agency (DLA) has made significant gains in providing a faster, more efficient logistics response capability. In many cases, improvements were made at little or no additional cost.

However, unlike many other efforts, this paper addresses response time reductions in areas that are known to have cost implications to wholesale organizations. Many logisticians believe that these costs will be minimal in light of the potential retail inventory reductions associated with faster wholesale replenishment. In this paper we quantify the costs incurred by DLA as depots reduce requisition bank time, hold time, and in-transit time. Furthermore, we investigated different stock positioning issues relating to range and depth of stock in order to provide a reduced response time at the lowest possible cost.

This work was co-sponsored by the DoD Logistics Response Time (LRT) Process Action Team. Therefore, this paper is part of a DoD-wide analysis of the cost and benefits associated with reducing LRT.

Defining, Measuring, and Predicting productivity Gains resulting from Logistics Management Automation

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One major benefit anticipated from the Materiel Management Standard System (MMSS) is increased productivity. However, defining and estimating the productivity benefit are difficult when baseline information is scarce and new system definition remains incomplete. The strategy attempted here is to view the MMSS as a device to diffuse productivity throughout DOD. Each migratory component of the new system is considered to embody the best current practices of its originating sponsor. Data to measure both current and best practices are given existing labor allocations to perform logistics management tasks. Generally, the DOD-wide

improvement from current practice to best practice provides an estimate of expected productivity gains.

Analysis of the United States Army's Ability to Execute Port Construction Operations

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This study, developed and executed in support of the United States Army Engineer Center at Fort Leonard Wood, Missouri, was designed to assess the active Army's ability to accomplish its wartime port construction requirements.
As a result of the current National Military Strategy of force projection, the U.S. Army's reliance on fixed and expedient seaports has increased. The availability of serviceable, deep water seaports is critical to achieving early success during most contingency operations. Army Port Construction Companies have the responsibility to renovate, repair and upgrade fixed port facilities and emplace temporary facilities during Logistics- Over-the-Shore operations. The last remaining active component (AC) Port Construction Company was inactivation on 30 September 1995. The impact of losing this unique AC capability is uncertain; however, its loss is conjectured to impact negatively on the Army's ability to achieve throughput levels necessary to meet timelines established by the Army Strategic Mobility Plan (ASMP). The potential impact of removing this unique capability from the active Army prompted this study.

The study's methodology was to obtain maximum information from historical data, future Army doctrine and subject matter experts (SME's). SME's from both the Engineer and Transportation communities were queried for input to the analysis. Information collected during the investigative research was used to develop alternative force structures and task lists for port renovation and repair operations. Alternative force structures were evaluated against the base case of a standard AC Port Construction Company to identify a preferred alternative. Commercial scheduling software was used to perform the analysis and to determine the time required for each alternative to complete required tasks using only its organic resources.

The study effort was completed and certified in November of 1995 and approved in February of 1996.

<u>Thursday, 1330-1500</u>
A Strategic Overview of the DLA Customer Sampling Plan

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The DLA Quality Council is concerned with many aspects of quality product delivery. In order to specifically address customer satisfaction, the DLA Quality Council approved the Inventory Control Point (ICP) Customer Assessment Program. During the initial phase of the program, information was gathered from customer focus groups. Based on these inputs, a customer survey questionnaire was designed to measure satisfaction at the customer level. During a follow-on phase, a statistical sampling plan for the DLA customers was required. This sampling plan was oriented to assist in the identification of specific customers to be surveyed.

The analysis employs several techniques designed to bring DLA's approach to customer service more in line with those commercially employed by the business community. These techniques use a completely innovative approach to customer stratification. In the past customers have always been grouped along classic types such as Service, unit type, and geographical location. However, under the new stratification plan customer are categorized more in line with the type of support they require. Furthermore, the new stratification plan produces several sets of smaller groups. These smaller groups allow for a more extensive and detailed sampling for particular areas of concern.

Utilization of this sampling plan provides for two distinct opportunities. First, a statistically sound and comprehensive surveying technique. Second, a cost reduction for the surveying process itself. This translates into a better stratification, which means better coverage of each area, and consequently fewer survey instruments having to be used.

Fleet Age Recapitalization

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A key component of readiness is modern equipment. America's soldiers sent into battle must have modern equipment capable of affording them both a technological advantage over their adversaries and the ability to support continuous battlefield operations. Equipment modernization is a continuous process over time. Because the Army is equipment intensive, the process of keeping the Army modernized is extensive. The recapitalization of the Army's fleet of 258,000 tanks, infantry fighting vehicles, artillery, helicopters, and tactical trucks is larger than almost all commercial fleets.

This study develops a methodology for evaluating the Army's level of modernization on the basis of fleet age and technology, and for determining the approximate level of RDA funding needed to achieve the Army's long-term modernization goals. The methodology revolves around a system's Refit or Replace (R2) point. This is the age at which a piece of equipment will no longer be mission capable in sufficient quantities, will not have sufficient capability or (in the case of combat systems) will not remain a technological advantage over similar equipment. At each such point in a system's life, a decision must be made on whether to refit (i.e. upgrade) or replace (i.e. buy more of the same or field a new system). Historically, the R2 point occurs a 8-10 year intervals for most systems. The methodology portrays the impact of alternative R2 decisions over time. Modernization decisions made now will continue to impact readiness over the next 20 years.

WG 27 — MANPOWER & PERSONNEL — Agenda

Chair: David Rodney, CNA
Cochairs: Maj Wayne Detwiler, USA ODCSPER
Maj Tom Garin, USAF AFPOA/DPYO
Herbert Shukiar, RAND
B. J. Wroblewski, OASA(M&RA)
Advisor: Ken Martell, CALIBRE Systems Inc.
Room: GIF, 357 B&D

Tuesday, 1030-1200
Enlisted Assignment Stability
W. M. Hix, Jan Hantley, et al, RAND

Navy Job Advertising and Selection System
Thuvan Nguyen, Timothy Liang and Ben Buclatin, Navy Personnel Research and Development Center

Promotion, Development and Distribution of Army Officers
Major Doug McAllister, Command and General Staff College, Fort Leavenworth

Tuesday, 1530-1700
Studies in the Estimation of US Army Recruit Production Factors
C. M. Keller, H. J. Larson and R. R. Read, Naval Postgraduate School

The Geographic Location of Recruiting Resources
Don Bohn, Edward Schmitz and Richard VanMeter, Navy Recruiting Command

Bonus Incentive Recruiting Model (BIRM)
Katsuaki L. Terasawa and Keebom Kang, Naval Postgraduate School

Wednesday, 0830-1000
Improving Training and School and Work: Lessons from RAND Research on Army Individual Training
John Winkler, RAND

Crew Warrior 3 (Analysis of Wartime Crew Ratio Requirements)
Don White, HQ ACC/XPM, 204, Langley AFB,

Enlisted Force Management: Issues for the Future
Sheila Nataraj Kirby and Harry J. Thie, RAND

Wednesday, 1330-1500
A New Missioning Model for the US Army Recruiting Command
MAJ Thomas J. Schwartz, HQ, US Army Recruiting Command (PAE)

Reducing First Term Attrition
Don Bohn and Edward Schmitz, Navy Recruiting Command

Graphical Data Display for Decision Makers
Kevin Lyman and MAJ Mick McGuire, HQ, US Army Recruiting Command (PAE)

Wednesday, 1515-1645
COMPOSITE GROUP VI SESSION .... GIF, Dupuy Auditorium

Thursday, 0830-1000
System Dynamics Approach to Developing US Army Personnel Policy
LTC David A. Thomas, MAJ Brigitte T. Kwinn and Abdullah Muhammed, United States Military Academy

A Simulation Model to Measure the Effect of Retirement, Recruiting, Promotion, and Distribution Policies on Personnel Unit Readiness for the Navy
Timothy Liang, Navy Personnel Research and Development Center, and Professor Jeffrey L. Kennington, SMU

Determining Personnel Management Policies using Computer Simulation in Face of Reduced Budgets and Force Realignment
LTC David Hutchison, LTC David A. Thomas, MAJ Robert G. Phelan, Jr. and Michael J. Kwinn, Jr., United States Military Academy

<u>Thursday, 1330-1500</u>
Refocusing Research Paradigms Toward Reducing Personnel Attrition
Martin Walker, U. S. Army TRAC - Lee

The Effect of Demographic Traits on Army Reenlistment Rates
Dr. Steven Wilcox, GRC International

Monthly Pay Chart Analysis
MAJ. Tom Garin, USAF, AFPOA/DPY

WG 27 — MANPOWER & PERSONNEL — Abstracts

<u>Tuesday 18 June, 1030-1200</u>
Enlisted Assignment Stability

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Approved abstract not available at printing.

Navy Job Advertising and Selection System

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Approved abstract not available at printing.

Promotion, Development and Distribution of Army Officers

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This presentation describes how the Army uses optimization to promote, develop, and distribute Army (Competitive Category) commissioned officers. First, we examine how the Army promotes officers in order to insure its ability to fill requirements by career field. Second, we examine how the Army develops officers into a secondary career field (functional area) in order to fill staff (TDA) requirements for field grade officers. Third, we examine how the Army distributes its officers to the major commands world wide given that there are more jobs (spaces) than officers (faces).

The US Total Army Personnel Command (PERSCOM) uses variations of the transportation model to solve these three problems. PERSCOM uses the promotions model prior to every Department of Army field grade promotion board to determine the minimum number of officers the Army must promote by career field. PERSCOM also used this model extensively during the drawdown to determine the minimum number of officers the Army had to retain by career field. PERSCOM uses the development model annually to designate basic branch officers into a functional area. PERSCOM uses the distribution model to develop its annual Officer Distribution Plan, which is briefed through the DCSPER to the Vice Chief of Staff, Army for distribution to the major commands.

<u>Tuesday 18 June, 1530-1700</u>
Studies in the Estimation of US Army Recruit Production Factors

C. M. Keller, H. J. Larson and R. R. Read
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Monterey, CA 93942-5103
Phone: 408-626-4035 Fax: 408-656-3407

Approved abstract not available at printing.

The Geographic Location of Recruiting Resources

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As the Navy Recruiting Command restructures to meet declining manpower needs, it becomes increasingly important to allocate resources in an efficient manner. This paper presents a model for optimally allocating recruiters and territory to locations in order to maximize production. The optimization model is based on a production model estimated at the zip code level. We estimate production as a function of population, area, distance to the recruiting station, and number of recruiters from both the Army and Navy. We apply the model to demonstrate how optimal geographic placement of recruiters can improve productivity.

Bonus Incentive Recruiting Model (BIRM)

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Approved abstract not available at printing.

<u>Wednesday 19 June, 0830-1000</u>
Improving Training and School and Work: Lessons from RAND Research on Army Individual Training

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Approved abstract not available at printing.

Crew Warrior 3 (Analysis of Wartime Crew Ratio Requirements)

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The ACCFLYER computer simulation model is used within ACC to determine aircrew requirements for wartime environments. ACCFLYER was the primary tool used to develop Crew Warrior III.2, a document designed to assist war planners in the deployment of the optimum fighter crew requirements for multiple wartime environments.

The ACCFLYER model uses real world operational and logistical data input parameters. Over 35 modeling factors are inputs to the ACCFLYER model: flight lead qualified, number and type of aircraft, sortie rate and duration, mission flight size, air crew duty day, air crew rest requirements, additional duties, alert duties, average pre/post mission brief times, probability of being shot down and recovered, and the probability of medical requirements are primary inputs to an ACCFLYER model.

Crew Warrior III.2, published August 1995, uses a model design of operational and logistical factors from several data sources: Air-Force wartime planning factors, information gathered from air crew members, and a survey of 15 squadrons that flew in DESERT STORM.

There are four tables within Crew Warrior III.2. To develop a not Mission, Design, and Series (MDS) specific crew requirement, war planners must select the table with the closest mission planning requirements. Select from the table's top line the sorties per aircraft and from the left column the average sortie duration. Triangulate these points to find the baseline air crew requirements. With a baseline, war planners will add additional duty requirements and divide by 24 aircraft. For this analysis 24 was used to establish an aircraft to pilot relationship. Once this relationship is known, the resulting ratio is multiplied by the deploying number of aircraft.

Enlisted Force Management: Issues for the Future

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The world environment is changing and changing very rapidly in ways that will have significant impact on the future military operating environment. As a result, the enlisted force of the 21st century will have significantly different roles and responsibilities. How to manage and shape this force will be a crucial question. In order to answer this, however, we need to know how the enlisted force is managed currently and what practices and procedures have worked (or not).

This paper has several objectives:

(1) Trace the historical evolution of enlisted force management over the past century and show that most of our military history (questions of size, skill and experience) has been largely driven by external events. Military personnel policies have emerged as a result of military needs and societal concerns. Attempts to manage the career force in the 1980s and 1990s have not been entirely successful.

(2) Characterize the current enlisted management system (with emphasis on the similarities and differences among the services) and compare this to selected private sector systems that may offer some valuable lessons.

(3) Raise some important issues that need to be answered when designing an enlisted career management system for the future.

<u>*Wednesday 19 June, 1330-1500*</u>

A New Missioning Model for the US Army Recruiting Command

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This presentation outlines the methodology and results of a study carried out by the US Army Recruiting Command to develop a new model for the assignment of quarterly recruiting missions to recruiting brigades and battalions. The current model assigns missions based on monthly recruit accession requirements and three years of historical DA and DoD enlistment contracts in each recruiting battalion zone. The new model uses business forecasting techniques to forecast production of contracts by recruit category in each battalion zone. The dynamic regression technique incorporates market and recruiting resource variables along with an autoregressive error model to capture ongoing changes in each battalion's market conditions and ability to produce contracts. These forecasts are input into an optimization model that ensures that all battalions have a nearly equal probability of achieving assigned missions. The overall result is an improved missioning process that identifies each recruiting battalion's potential and equitably assigns recommended missions to each recruiting brigade.

Reducing First Term Attrition

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The Navy has experienced increased first term attrition. This paper analyzes recruits enlisting during FY91-93 using a logistic regression model, identifying key factors that explain the attrition differences. We show how such factors as RTC management and delayed entry program practices have led to increased attrition, and show how alternative policies can reduce attrition.

Graphical Data Display for Decision Makers

Kevin Lyman and MAJ Mick McGuire

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The purpose of this presentation is to demonstrate two methods of displaying data in geographical and graphical manners for decision makers to make quick, quality decisions. This system is called Executive Decision Support System (EDSS). Both methods use relatively common software, Map Info and Excel. The adage " a picture is worth a thousand words" is even more apropos in this era of information deluge.

The first method uses a LAN version of Map Info to geographically represent production data of applicants across the United States by unit who contract, access or DEP loss into the Army. The production data changes daily and is produced on spreadsheets and in paper copies. Using a common server with Map Info allows decision makers to see the geographical representation of pages of spreadsheet data quickly, easily, and accurately. The source of the data is centralized.

The second method uses individual copies of Excel, but the Excel Workbooks are stored on a common server. This data has been typically distributed to decision makers from a variety of sources (Directorates) on a habitual basis. The EDSS represents the data graphically, using a user friendly interface that allows decision makers to view up to date data about any directorate. With this method, the proponent of the data is responsible for the data.

Wednesday 19 June, 1530-1700
COMPOSITE GROUP VI SESSION
GIF, Dupuy Auditorium

Thursday 20 June, 0830-1000

System Dynamics Approach to Developing US Army Personnel Policy

LTC David A. Thomas, MAJ Brigitte T. Kwinn and Abdullah Muhammed, Department of Systems Engineering, United States Military Academy
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The enlisted personnel management process is a complex and dynamic system. Changes in one area, such as the reduction in the number of requires accessions, may cause an unexpected change in another area. Dynamic systems analysis is a methodology that considers these cause and effect relationships and models them using continuous time simulations. This paper explains how a continuous time simulation model was developed and used to identify leverage points within the enlisted personnel system. Previous models considered specific areas of the system and were integrated together to make policy decisions. The dynamic simulation model uses continuous time simulation software for an IBM compatible personal computer and considers all the areas together to capture the macro level interactions of the enlisted personnel system. This PC based decision support system offers insight into the "levers" that affect recruiting missions and overall Army end strength.

A Simulation Model to Measure the Effect of Retirement, Recruiting, Promotion, and Distribution Policies on Personnel Unit Readiness for the Navy

Timothy Liang and Professor Jeffrey L. Kennington, Navy Personnel Research and Development Center, 53335 Ryne Road, San Diego, CA 92152-7250.
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Readiness is a large, complex, but not very well defined problem. One of the major issues is related to the measurement of readiness, the impact of readiness, and the prediction of readiness. To resolve this issue, a tool needs to be developed to quantify various readiness factors with a quantitative model that can measure the impact of readiness and predict readiness.

Personnel unit readiness ratings is one of the major quantitative measures of readiness. We believe that improving the tool to distribute and assign the right sailors to the right jobs with the right skills for the right units at the right times with given resources would help improve the unit readiness level. We have experimented in developing a large static assignment optimization model to improve assigning and training sailors to jobs to achieve the higher level of unit readiness. Our development of the static optimization model encouraged us to move one step forward to incorporate more variables which affect readiness dynamically.

Our current research effort is to develop a model to measure and predict impact of monthly personnel unit readiness ratings resulting from the changes in personnel policies, such as recruiting, retirement, promotion, and distribution. We developed a conceptual deterministic simulation model for this purpose. The model requires aggregation of both billets and sailors to provide an ability to manipulate vast amounts of data related to 400,000 sailors and the 500,000 billets. The planning horizon is 48 months into the future.

Determining Personnel Management Policies using Computer Simulation in Face of Reduced Budgets and Force Realignment

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Since the end of the Cold War, the United States Army personnel system has been in a constant state of turmoil. There have been cuts in personnel and budget and a tremendous number of units have deactivated. There will be more cuts until the future force stabilizes. Current models uses trends to predict future readiness. These models are so large that run times enter into days and weeks. They are so complex that there is no sensitivity analysis presented with this output. With the tremendous number of policy issues facing personnel managers today, they need more responsive, easier to understand and use models. With the advances in technology in recent years, models such as these can be developed.

We present a simulation model in this a paper being developed for the Plans and Analysis Branch, Enlisted Personnel Management Division (EPMD), Personnel Services Command (PERSCOM). This model allows the user to quickly analyze the effects on readiness and costs of policy changes, force structure changes and further personnel reductions. The model in this paper is a proof of principle. We develop the model using one MOS, 19K. Using simulation technology, personnel managers can quickly and easily conduct sensitivity analysis on input parameters and continuation rates. This model is intended to run in a PC-based Windows environment.

Thursday 20 June, 1330-1500

Refocusing Research Paradigms Toward Reducing Personnel Attrition

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Attrition is a problem because it costs the Army hundreds of millions of dollars each year. The Army incurs not just recruiting and training costs for soldiers leaving early, but also the cost of out-processing, providing unemployment compensation, recruiting and training of replacements, and in some cases veterans and medical benefits. Since the inception of the all-volunteer Army, considerable research has been aimed at explaining the reasons underlying Army personnel turnover or attrition. Much of this research has been focused on developing the tools for screening-out applicants prone to attrition behavior. The purpose of this paper is three-fold: to review the research on personnel turnover or attrition, to identify the current deficiencies in the research literature, and to provide a direction for future empirical research aimed at reducing Army attrition.

During the 1980s Army recruiting policies were modified based on this secondary research. However, the results have not been as predicted. This paper highlights previous empirical research and presents a research framework directed toward reducing Army attrition.

The Effect of Demographic Traits on Army Reenlistment Rates

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New multivariate logistic regression models of historical reenlistments distinguish the separate contributions of demographic, occupational, economic, trend, and policy factors on the probability of reenlistment for enlisted soldiers in the U.S. Army with less than ten years of service. An exhaustive study of the multivariate functional form of these effects reveals that they have a far more complex structure than presented in previous studies. While reenlistment rates in the Army are strongly related to demographic traits such as race, gender, education, mental category, marital status, and numbers of dependents, these demographic effects vary according to occupational factors such as occupational specialty group, term of service, and pay grade. The differences attributable to racial / ethnic group, mental category, and education have also changed over the years. In addition to direct effect of demographic traits on retention, they also affect a soldier's response to economic factors, selective reenlistment bonus offers, and the availability of training seats for reclassification in conjunction with reenlistment.

Monthly Pay Chart Analysis

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The Eighth Quadrennial Review of Military Compensation (QRMC), a panel created by President Clinton to craft a pay system for the 21st century, proposed a new pay chart that rewards promotion more and longevity less. The Air Force Personnel Operation Agency analyzed the current and proposed monthly pay charts. This presentation focuses discussion on some of the key points in this analysis. It represents work "in progress."

WG 28 — RESOURCE AND COST ANALYSIS — Agenda

Chair: Thomas P. Frazier, Institute for Defense Analyses
Cochairs: Capt. Catherine Lin, Air Force Cost Analysis Agency
George W. Covert, Jr., US Army Cost and Economic Analysis Center
Steven Siegel, US Army Concepts and Analysis Agency
Lt. Tim Anderson, Navy Center for Cost Analysis
Room: GIF, 359-B

Tuesday, 1030-1200
Environmental Investment Analysis
James J. Connelly, U.S. Army Concepts Analysis Agency

Evaluation of Land Value Study (ELVS)
Steven Siegel U.S. Army Concepts Analysis Agency

Political and Economic Risk in Countries and Lands Evaluation Study (PERICLES)
J. Theodore Ahrens, U.S. Army Concepts Analysis Agency

Tuesday, 1530-1700
Creating a Decision Support Tool for Allocation of Infrastructure Funding for Use at U.S. Army Installations
Capt. Thomas E. O'Hara, Jr., and Capt. Elizabeth A. Lind, United States Military Academy

Yearly Analysis of Technology for Installation Readiness Prioritization (YATIRP)
James J. Connelly, U.S. Army Concepts Analysis Agency

Wednesday, 0830-1000
Deriving Minimum Percentage Error CERs under Zero-Bias Constraints
S.A. Book and H.S. Gobreial, The Aerospace Corporation

RiskTRAC: A Management Tool for Prioritizing, Displaying, and Tracking Program Risk
C.C. Cho, P.R. Garvey, and R.J.Giallombardo, The MITRE Corporation

Wednesday, 1330-1500
A Dynamic Model of Defense Contractor Overhead Costs
Thomas P. Frazier, Institute for Defense Analyses

Army National Guard Reduces Simulator Operating Costs with Optimization Models
Philipp A. Djang, USATRADOC

Geo-Economics Futures and their Implications for Military Strategies and DoD Budgets
Michael Jeffers, Naval Surface Warfare Center, Carderock Division

Wednesday, 1515 - 1645
COMPOSITE GROUP VI SESSION .... GIF, Dupuy Auditorium

Thursday, 0830-1000
Contractor Cost Data Reporting (CCDR) System: Enhancing Data Availability
Jack Cloos, Institute for Defense Analyses and Gary Bliss Office of the Secretary of Defense (PA&E)

The Navy Cost Database
CDR William Mickler, Naval Center for Cost Analysis

Thursday, 1330-1500
Exploiting Information Technologies to Address DoD's Environmental Dollar Issues
Edmund O. Acosta, US Army ATCOM, Patrick Kielbasa, Dynamics Research Corp., Faith H. Teitelbaum, US Army CECOM

A Statistical Trap for the Cost Analyst
William Boston, US Army Cost and Economic Analysis Center

Information Technology and the PPBES Process
LTC Eugene N. Ramsey, ASA(FM&C) and MAJ W. Addison Woods, US Army Budget Office

<u>Tuesday, 1030-1200</u>
Environmental Investment Analysis

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The Pollution Abatement and Prevention Analysis (PAPA) is a methodology for development and evaluation of environmental investment, using project benefit measures (e.g., cost savings, pollution reduction) and budget and policy parameters as constraints, to respond to one or more investment objectives selected to maximize the benefits, or alternately, minimize investment and/or life cycle costs.

This paper describes the application of PAPA in two environmental resource management situations. The first application is management of the Army pollution prevention program, where investments are made in pollution prevention opportunities at individual Army installations. The second is an evaluation to determine if such an analytically-based approach can assist in developing policies that facilitate a comprehensive approach to prioritizing environmental research, development and technology development (RDT&E) requirements.

Evaluation of Land Value Study (ELVS)

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ELVS developed and demonstrated a methodology for estimating the operations and support costs of using land at Army installations for the training of ground forces. The Deputy Chief of Staff for Operations and Plans has indicated that operational readiness should reflect the total cost of preparing a unit to go to war to include the costs of using land for training purposes. The ELVS methodology demonstrated how land management and maintenance costs could be integrated with weapon systems training costs in two case studies that addressed eight types of active Army battalions at Ft. Hood and selected sites in USAREUR. The study also established measures and values for Army-wide standards for training land carrying capacity and how they can be incorporated in the PPBES process and the Army's Installation Status Report (ISR).

Political and Economic Risk in Countries and Lands Evaluation Study (PERICLES)

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PERICLES developed and demonstrated an analytical methodology that incorporates quantifiable measures of the political, economic, environmental/infrastructure, social/cultural, and military risk associated with foreign nations as part of the Army's overall threat assessment. This study, conducted for the Office of the Deputy Chief of Staff for Intelligence, evaluated historical data on 19 factors that when integrated would be used to identify areas of potential instability for 200 countries. A graphical interface tool was also developed and demonstrated to display the results and allow for user interaction. The basis for this study arose from the growing need in the defense and security community to synthesize and analyze information regarding the causes of conflict in addition to military factors.

<u>Tuesday, 1530-1700</u>
Creating a Decision Support Tool for Allocation of Infrastructure Funding for Use at U.S. Army Installations

Capt. Thomas E. O'Hara, Jr., and Capt. Elizabeth A. Lind
Operations Research Center
Department of Systems Engineering
United States Military Academy
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Recently, the U.S. Army has fielded a new annual report, the Installation Status Report (ISR). Part I of the ISR gives a complete report on the condition of each facility at the Installation, a and the approximate cost to repair the facility. The Installation Decision Support Model (IDSM) assists installation commanders in accessing and utilizing the ISR data, and other data bases. It will eventually be able to assist installation level commanders in evaluating the impact of various funding alternatives. Currently a manually adjustable, goal oriented, priority system is being considered for rank ordering the facility repair costs for funding. Eventually this model will incorporate Part II (Installation Environmental Issues) and Part III (Installation Support and Services) of the ISR.

Yearly Analysis of Technology for Installation Readiness Prioritization (YATIRP)

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YATIRP provides a methodology for development and evaluation of investment strategies in support of readiness management decisions at Army installations. It produces and evaluates strategies using installation "C-rating" and "Color" improvements as benefit units, constrained by funding levels and policy parameters supporting these improvements. The installation C-rating and color improvements data are available from the HQ Army Installation Status Report decision support system. Using these data, the impacts of decrements in funding, as well as other "what ifs", can be evaluated in terms of C-rating/color shifts.

Wednesday, 0830-1000

Deriving Minimum Percentage Error CERs under Zero-Bias Constraints

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Approved abstract not available at printing.

RiskTRAC: A Management Tool for Prioritizing, Displaying, and Tracking Program Risk

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This paper presents a management tool for prioritizing, displaying and tracking program risk. The tool, called RiskTRAC, is a database application that provides program offices a structure for conducting continuous risk assessments. As a management tool, RiskTRAC aids in identifying where engineering assets are best applied to mitigate potentially crippling areas of risk to a program.

RiskTRAC rank-orders and tracks project-defined risk events as a function of their estimated cost, schedule, and technical performance impacts. This includes quantifying the effects of coupled (dependent) risk events.

RiskTRAC is evolving as a PC application. A beta version of the software is available. A copy of the program, along with installation procedures, can be obtained by contacting the authors.

Wednesday, 1330-1500

A Dynamic Model of Defense Contractor Overhead Costs

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This paper presents a dynamic model of Department of Defense (DoD) contractor overhead costs. Traditional accounting and statistical methods are inadequate when estimating the behavior of overhead costs. These traditional models are particularly insensitive to capturing the "sticky" nature of overhead costs - they generally do not rise or fall in lockstep with changes in the amount of activity in the plant. Typically, a contractor cannot immediately adjust overhead to the new situation because of such things contractual obligations with suppliers or workers, inertia, and the cost of change. The IDA model takes into account this "stickiness" in estimating changes in overhead costs. The model, which is a variant of the partial adjustment dynamic model first proposed by Nerlove, was constructed using data from four large DoD aerospace contractors. The data cover the 1970-1993 time period.

Army National Guard Reduces Simulator Operating Costs with Optimization Models

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Between now and the year 2000, the US Army will field 21 high-fidelity mobile networked tank and infantry fighting vehicle training simulators called the Mobile Close Combat Tactical Trainer (M-CCTT), to Army National Guard and Reserve Component. Each Mobile CCTT (M-CCTT) consists of a number of simulator vans (networked computers), a maintenance van, and a generator trailer, for a total of 6 (armor) to 7 (infantry) tractor trailer vans.

The Systems Manager-Combined Arms Tactical Training, Fort Leavenworth, Kansas; and the Army National Guard Bureau, Washington, DC are responsible for M-CCTT fielding and management. An initial hand-analysis using a U.S. map and concentric circles on transparent acetate to determine the home-base locations for the M-CCTT did not yield a good solution. They asked us to identify the best locations to home-base the M-CCTT fleet as part of the fielding plan for the simulators. In addition to determining where to home-base the fleet, we developed an efficient routing scheme. Our approach consists of sequentially solving a number of combinatorial optimization models.

Geo-Economics Futures and their Implications for Military Strategies and DoD Budgets

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The study investigates the connection between national military strategies, geoeconomic conditions and the potential DoD budget levels that might result. It was conducted in support of the 21st Century Surface Combatant Force Architecture Assessment to develop a better understanding of the nature of Navy budget levels as world conditions and U.S. interests change. A macro-economic model was developed and future Navy budget levels were computed based on Federal Government priorities, national personal income and tax levels. Military strategies were linked to the national priorities. Insights into likely budget levels and their connection to affordable force levels are discussed.

Thursday, 0830-1000

Contractor Cost Data Reporting (CCDR) System: Enhancing Data Availability

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Gary Bliss
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(703) 695-4348

The CCDR system was established in 1973 by DoD to collect and distribute contract cost data from defense contractors in standard formats for use in cost estimating. The Institute for Defense Analyses (IDA) completed an assessment of that system in 1994 and suggested many actions that could be taken to improve operational efficiency and effectiveness. Subsequently, the Office of Director, Program Analysis and Evaluation (OD/PA&E) began reengineering the CCDR system and requested IDA's assistance in implementing several improvement efforts. These involved automated contractor reporting, electronic data interchange (EDI), and automated collection and distribution of CCDR within DoD.

This paper describes the prototype demonstration project involving two major defense contractors that was developed to assess the feasibility of implementing these recommendations throughout DoD and industry. We divided the CCDR system into three major segments: 1) contractor reporting, 2) establishment of a DoD database(s), and 3) data distribution and use. The presentation summarizes the current CCDR system and the need for improvement in each of these segments and highlights the results and lessons learned from the demonstration project.

The Navy Cost Database

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This presentation will describe the current effort to convert the Navy Visibility and Management of Operating and Support Costs (VAMOSC) flat-file database to a relational database to improve and expand access to historical Navy operating and support costs. A time table for the conversion effort will be presented. A delineation of the functional requirements to capture the Total Cost of Ownership of Navy weapon systems will be identified. The improvements are intended to make the system more complete, more timely, and more accessible to users throughout DoD.

The VAMOSC database contains operating and support costs incurred over the last 18 years for Navy ships and over the last nine years for Navy and Marine Corps aircraft. Detailed maintenance data can be presented at the four-character Equipment Identification Code-five-character Expanded Ship Work Breakdown Structure for ships and the seven-digit Work Unit Code for aircraft. Recent additions to the VAMOSC database include costs incurred by missiles and torpedoes, selected automated information systems and the ships operated by the Military Sealift command. The Navy Costs Data Base, which will be accessible via the Internet, will provide all of these data along with various tools to assist cost analysts and other users of the data.

Thursday, 1330-1500

Exploiting Information Technologies to Address DoD's Environmental Dollar Issues

Edmund O. Acosta, US Army ATCOM, Patrick Kielbasa, Dynamics Research Corp., Faith H. Teitelbaum, US Army CECOM

Approved abstract not available at printing

A Statistical Trap for the Cost Analyst

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This presentation is intended for cost analysts, rather than statisticians. The statistics involved are not complex. The emphasis is on explaining why they work, in cost estimation terms; clarifying their effects; and helping analysts to avoid problems. (The same is not true of this abstract, which mentions the theory, but without explanation).

Program costs are estimated by adding up point estimates of costs of program elements. For this to work, the numbers used for the element costs must be the expected costs for each element-the means of the probability distributions for the element costs. Because distributions are invariably skewed, the expected values are not the most probable costs. In general, the point estimate of the cost of a program element must not be the most probable cost for that element. If most probable costs are used, the total is meaningless.

When costs are estimated by engineering judgment, the result is usually the most probable cost of the item. If this number is used as a point estimate, it will bias the estimate low. However, if the engineer also gives estimates of the highest and lowest possible costs, a probability distribution of the cost of the item. The means of this distribution is an estimate of the expected cost of the item, and can be used as a point estimate.

Information Technology and the PPBES Process

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Approved abstract unavailable at printing.

WG29 — READINESS — Agenda

Chair: Jack Leather, Defense Manpower Data Center/TREAD
Cochair: Mike Wagner, Dynamics Research Corporation
Cochair: Linda Bors, USSTRATCOM/J612
Cochair: LCDR Julie Dougherty, Naval Postgraduate School
Advisor: Mike Parmentier, ODUSD(R)(R&T)
Room: GIF, 353-A

Tuesday, 1030-1200
The Readiness Baseline
Dr. Kathleen Van Trees Medlock, ODUSD(R)(RP&A)

Joint Automated Readiness System (JARS)
LtCol Paul Neal, USA, J-3 Readiness Division, Joint Staff

Joint Readiness Automated Management System (JRAMS)
Maj Paul F. Gillis, USMC, J-32, Readiness & Technology Division, U. S. Atlantic Command

Tuesday, 1530-1700
Assessing Readiness at USSTRATCOM
LCDR David Wisniewski, USN, USSTRATCOM/J441

Wednesday, 0830-1000
Understanding Navy Readiness
Dr. Laura J. Junor, Center For Naval Analyses

An Emerging Econometric Model of Material Readiness - Resources-to-Readiness Econometric Models in the Navy
Eliot Feldman & Mark McLaughlin, Mathtech, Inc.

The Relationship Between Training and Unit Performance for Naval Patrol Aircraft
Colin P. Hammon & Stanley A. Horowitz, Institute for Defense Analyses

Wednesday, 1330-1500
Joint Mission Essential Task Lists (JMETL): A Foundation for Mission-Based Readiness Assessment
Dr. Michael Wagner, Dynamics Research Corporation

The Joint Training System: A Pillar of Joint Readiness
LCDR Pat Clark, USN, Joint Warfighting Center

NavalCAT - A Readiness and CDR's Assessment Tool
CDR Charles W. Kennard, USN, Doctrine Development Division, Naval Doctrine Command

Wednesday, 1515 - 1645
COMPOSITE GROUP VI SESSION .... GIF, Dupuy Auditorium

Thursday, 0830-1000
Warfighting Lens Analysis (WFLA) 98-12 Force Package Analysis
CPT(P) Thomas M. Cioppa, USA, TRADOC Analysis Center - Study and Analysis Center (TRAC-SAC)

A Simulation Model to Measure the Effect of Retirement, Recruiting, Promotion, and Distribution Policies on Personnel Unit Readiness for the Navy
Dr. Timothy T. Liang, Navy Personnel Research and Development Center and Dr. Jeffery L. Kennington, Southern Methodist University

Fleet Age Recapitalization
Maj Peter A. Davidson, USA, Programs & Priorities Division, HQDA, DCSOPS - Force Development
Andrew Kourkoutis, Value Added Analysis Division, Concepts & Analysis Agency, U.S. Army

Tuesday, 1030-1200
The Readiness Baseline

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As the Armed Forces have downsized during the 1990s, maintaining force readiness and preventing future shortfalls has been one of the primary concerns of the Department of Defense. The General Accounting Office, the Congressional Budget Office, and the Readiness Task Force have all addressed the desirability of identifying indicators of force readiness.

The Readiness Baseline (RBL) project is developing a comprehensive set of readiness indicators which maybe used to understand, predict, and prevent readiness shortfalls. The RBL will be used to assist in current readiness assessments, to synchronize readiness related budget data, and to participate effectively in the public discussion of the Armed Forces readiness posture.

The RBL framework addresses both unit readiness and joint readiness. Unit readiness is structured into three functional areas: personnel, equipment, and training. Preliminary indicators have been developed for these areas. Joint readiness is structured into two categories: deployment and employment. Initial research into joint readiness indicators has begun.

Joint Automated Readiness System (JARS)

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This presentation will introduce an automation system. The system is being developed to implement a new vision of readiness held by the Chairman, Joint Chiefs of Staff. The system is the Joint Automated Readiness System (JARS). The new vision of readiness consists of three levels: tactical readiness (unit), operational readiness (theater), and strategic readiness (national). JARS is a system for accessing readiness type data; manipulating the data based on pre-established "business rules"; and providing views of this readiness type data at the three readiness levels.

JARS is an application as well as a concept of data and systems integration. It is made possible through technology developed through the Advanced Project Agency (ARPA) Joint Task Force (JTF) Advanced Technologies Demonstration (ATD). The developmental technologies pass through the Joint Program Office's (JPO) Leading Edge Services (LES) which transitions the prototype capabilities into a full production system. The full production system is then integrated into the Global Command and Control System (GCCS), supported by the Defense Information Support Agency (DISA).

The JARS concept is to identify and borrow from existing systems and capabilities. JARS will use their logic-flow, code, and/or documentation to build the respective capabilities into a "core" application. Using ARPA's technology it will then link to the GCCS. This will be possible using a data service with the Common Object Request Brokerage Architecture (CORBA)

Joint Readiness Automated Management System (JRAMS)

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CINCUSACOM in partnership with DARPA is developing a capability to dynamically portray and analyze the impact of force readiness on employment decisions. The foundation of this concept is based on providing access to multiple data sources, independent of their structure, into a fuzed, single format that provides the warfighter tailored readiness information from multiple sources and in multiple, logical formats. One of the project's initiatives is the Joint Readiness Automated Management System (JRAMS). JRAMS allows high-level planners to assess current availability and preparedness of any combination of forces or supplies. Data used to determine readiness comes from a variety of databases and is graphically displayed in a way that allows the planner to have total force visibility and then assess the impact of one plan against another. This information, which previously had to be retrieved and tabulated, is now available from a single JRAMS interface. Every time a user requests an update on force readiness, JRAMS queries the databases, assimilates the data and performs calculations, then updates the information on the graphical display.

This paper details a USACOM readiness initiative that links leading edge technology directly with its intended end-user. The project provides the military customer constantly updated, detailed and reliable information on status of forces, joint planning efforts, logistics, and related data. The system successfully links geographically distant databases in different database management systems to provide the warfighters a unique planning assessment capability.

Tuesday, 1530-1700
Joint Mission Essential Task Lists (JMETL): A Foundation for Mission-Based Readiness Assessment

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The Joint Staff (J-7) is implementing a process by which joint force commanders analyze their missions and establish mission requirements in the form of JMETL. A JMET specifies the task to be performed, under what conditions, and to what standard using the common language provided in the Universal Joint Task List (CJCSM 3500.04). JMETs provide the basis for conducting joint training and for generating task-based assessment data.

Current readiness assessment is unit-based and cannot answer questions about mission readiness. In order to make mission-

based assessments, task-based performance data is required. Task-based assessment data, containing information on the mission context in which it was collected (conditions information) and based on results-oriented measures of performance (from the UJTL), can be used to determine the readiness to perform a particular mission. If task performance in one mission context can be translated to other mission contexts after the fact (adjusting for differences in conditions), then "constructive" assessments can be made of mission readiness. The JMETL process provides the capability for making such translations. This paper will describe the logic of the JMETL process and will provide examples to illustrate how assessment data can be used to judge mission readiness.

The Joint Training System: A Pillar of Joint Readiness

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Readiness is the right people, properly equipped, trained as a team capable of fighting and winning our nation's wars. That formula with its fundamental dependent relationships relates the commander's age old problem. "Given my assigned missions how do I best prepare my forces to successfully accomplish those missions." Also, "If I have done everything I can and still determine that I can not accomplish the mission how do I tell my boss in terms so that he can help me." Above all else, the joint training system is designed to ensure the Armed Forces of the United States are trained to fight and win the nation's wars. Consequently, training proficiency, equipment availability, and personnel resources are the three pillars of joint readiness-- creating and maintaining a trained and ready force able to perform assigned missions.

The emerging Joint Training System as directed in the Joint Training Master Plan is the method which links joint training to joint readiness. The Universal Joint Task List (UJTL), developing Joint Mission Essential Task Lists (JMETLs), preparing task-based joint training plans, executing and evaluating task-based joint training, and assessing training proficiency based upon demonstrated performance establish a uniform system for joint training readiness assessment and more importantly correcting those deficiencies and validating the corrections within the same task-based training system.

Using this system, the combatant commander can assess training readiness: a Pillar of Joint Readiness.

NavalCAT - A Readiness and CDR's Assessment Tool

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The focus of this presentation is on the Navy efforts to adopt and utilize the framework and common language provided by the Universal Joint Task List (UJTL). In particular, the presentation will focus on issues of readiness and readiness reporting using this tool to add greater clarity and objectivity to the readiness assessment process.

Navy efforts with respect to the UJTL can be divided into two broad areas. The first is to develop a robust, comprehensive list of Naval tasks, conditions and standards. The second deals with how the Navy is applying this new tool. From training to restructuring the Navy's Lessons Learned data base to the procurement process, program managers are adopting this new task based methodology to articulate requirements and focus efforts.

This paper will detail some recent Navy initiatives to apply the UJTL methodology. It will address the logic behind the development of a software package designed to aid operational planners in building Navy Mission Essential Task Lists (NMETLs) in response to higher level tasking. The value added of NMETLs to the ability of an operational commander to accurately assess his unit's or assigned unit's ability to execute a mission is just now being explored. We believe a NMETL based planning software, fed by data formatted within the framework of a Universal Naval Task List (UNTL), will for the first time provide commanders the ability to accurately judge an individual unit's readiness to carry out a specific task, under specified conditions, to a specific level of performance.

Wednesday, 0830-1000
Understanding Navy Readiness

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This work presents new techniques for tracking and predicting readiness. The study's goal is to understand why readiness changes and whether recent changes warrant concern.

Benchmarking. We cannot begin to evaluate recent changes in readiness without first putting them into historical context. We collected unit level data on about 100 readiness indicators, quarterly from 1978 through 1994. Using a mathematical technique called cluster analysis, we found that readiness data sort themselves into distinct periods of low and high readiness.

Summarizing. We offer a technique that summarizes similar indicators into one index that can be easily tracked through time and across units. We illustrate this technique on measures of enlisted personnel quality and derive a personnel quality index for the crews of surface combatants. We show that personnel quality has been increasing since 1982 and is significantly higher in 1994 than it has been at any time in the last 15 years.

Modeling. The next part of our analysis identifies readiness drivers. We built a re-cursive system of readiness equations around the four SORTS resource areas. The equations explain the status of readiness in these areas using variables such as underway time, parts inventories, and deployment cycles. Our findings suggest that personnel quality is an extremely important determinant of readiness.

Predicting. The result of our analysis can be used to predict near-term readiness: We can use our benchmarks to determine where current readiness is heading. We can use our estimated equations and the movements of the drivers to approximate future readiness.

An Emerging Econometric Model of Material Readiness - Resources-to-Readiness Econometric Models in the Navy

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Since 1981, the Resources, Warfare Requirements, and Assessments Division of the Office of the Chief of Naval Operations, N81, has sponsored the development of statistical models that relate the budget to measures of materiel readiness. These models are currently used by CNO to project the impact of the POM upon materiel readiness.

Five models have emerged: the MC/FMC, (Mission Capable/Full Mission Capable) model (1981), the Ship Model (1986), the Resources-to-Sortie Model (1994), the Type/Model/Series MC Model (1994), and the Average Customer Wait time (ACWT) Forecasting Model (1995). A sixth model is in the early stages of development: the Inventory Flow Model--a network model of the Navy's spare parts inventory system.

These models are linked to each other. The MC/FMC model has served as the foundation for two of the models: the Type/Model/Series MC model and the Resources-to-Sortie Model. The ACWT model was designed to provide inputs to the Ship Model and the Type/Model/Series model, while the Type/Model/Series MC model provides input to the Resources-to-Sortie Model. The planned Inventory Flow Model will supply a forecast of volume of Ready-for-Issue spares to the Ship, Aviation, and ACWT models.

This presentation will outline the structure of this emerging econometric model of the Navy's materiel readiness, concentrating upon structure, technique, and practical use of the models' output.

The Relationship Between Training and Unit Performance for Naval Patrol Aircraft

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This paper develops quantitative relationships between how much air crews train and how well they perform important aspects of their missions. It examines the performance of Navy Patrol air crews in the P-3 aircraft. The performance data were derived from graded torpedo exercises flown on an instrumented range. The crew must detect, classify, track, and successfully launch an exercise torpedo to qualify in the exercise. The P-3 carries a multi-person crew, including a pilot, tactical coordinator (TACCO) -- both officers, and enlisted sensor operators. Data covering both the long-term and short-term training experience of crew members was gathered. Training in the aircraft and in simulators were both considered. Statistical analyses were performed to estimate relationships between training and performance. The analysis showed both short- and long-term positive effects of flying hours on air crew performance. Long-term experience was more important. Although data on long-term simulator use were not available, recent simulator experience was found to be particularly cost-effective.

<u>Wednesday, 1330-1500</u>

Assessing Readiness at USSTRATCOM

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U.S. Strategic Command is a known leader within DoD in assessing readiness. This presentation will review how the command assesses readiness and displays the results. Several aspects of readiness assessment will be examined: identifying and defining readiness measures, monitoring and reporting systems, quantification of systems performance, analytical techniques, display of the assessments, and assessing future readiness. Assessments of the various force elements, bombers, ICBMs, SLBMs, Reconnaissance assets, and C4I will be illustrated with special attention on how C4I performance is measured and assessed.

<u>Wednesday, 1515 - 1645</u>
COMPOSITE GROUP VI SESSION
GIF, Dupuy Auditorium

<u>Thursday, 0830-1000</u>
Warfighting Lens Analysis (WFLA) 98-12 Force Package Analysis

CPT Thomas M. Cioppa, USA
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EFFORT (Early Entry Force Tailoring Tool) was used in support of Headquarters, Training and Doctrine Command's (TRADOC) Warfighting Lens Analysis (WFLA) 98-12 to analyze the Army's programmed force packages over time [current-1996, end of POM (program objective memorandum)-2003, and end of EPP (extended planning period)-2012] to address the following hypothesis: "Limited modernization funding is causing warfighting capability differential of the force packages to increase over time with the capabilities of some force packages not maintaining an overmatching capability."

EFFORT is a mathematical optimization application incorporating lethality, survivability, deployability, sustainability, and tempo constraints to mathematically optimize a force package or determine the deviations from goals desired for a force. During optimization, a multi-objective linear goal programming formulation is encoded into the General Algebraic Modeling System (GAMS) and, subsequently, solved via a mixed-integer optimization algorithm. EFFORT uses fuzzy set theory and simulation techniques (stochastic variability) to capture the synergistic effects of various combinations of units.

Each force package (using the proposed 10 division force structure) was analyzed independently in a SWA (Southwest Asia) and NEA (Northeast Asia) scenario using EFFORT to determine how the force package achieved the lethality goals of destroying threat air, threat artillery, threat armor, and threat air defense, the survivability goal of retaining combat power, the deployability goal of deploying the force package according to the NMS (National Military Strategy), and the sustainability goals of supplying the force with the required ammunition and fuel for the

first three days of a heavy offensive operation. The relative importance of achieving these goals for each scenario was assessed by the WFLA (Warfighting Lens Analysis) Warfighting Council. A comparison was made between the force packages to validate the hypothesis.

A Simulation Model to Measure the Effect of Retirement, Recruiting, Promotion, and Distribution Policies on Personnel Unit Readiness for the Navy

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Readiness is a large, complex, but not very well defined concept. Several major and unresolved issues involve the measurement of readiness, the impact of readiness, and the prediction of readiness. In order to address these concerns, a tool needs to be developed to quantify various readiness factors with a quantitative model that can measure the impact of readiness and predict readiness.

Personnel unit readiness ratings is one of the major quantitative measures of readiness. We believe that improving the tool to distribute and assign the right sailors to the right jobs with the right skills for the right units at the right times with given resources would help improve the unit readiness level. We have experimented in developing a large static assignment optimization model to improve assigning and training sailors to jobs to achieve the higher level of unit readiness. Our development of the static optimization model encouraged us to move one step forward to incorporate more variables which affect readiness dynamically.

We are currently developing a model to measure and predict monthly personnel unit readiness ratings resulting from the changes in personnel policies, such as recruiting, retirement, promotion, and distribution. We developed a conceptual deterministic simulation model for this purpose. The model requires aggregation of both billets and sailors to provide an ability to manipulate vast amounts of data related to the 400,000 sailors and the 500,000 billets. The planning horizon is 48 months into the future.

Fleet Age Recapitalization

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A key component of readiness is modern equipment. America's soldiers, sent into battle, must have modern equipment capable of affording them both a technological advantage over their adversaries and the ability to support continuous battlefield operations. Equipment modernization is a continuous process over time. Because the Army is equipment intensive, the process of keeping the Army modernized is extensive. The recapitalization of the Army's fleet of 258,000 tanks, infantry fighting vehicles, artillery, helicopters, and tactical trucks is larger than almost all commercial fleets.

This study develops a methodology for evaluating the Army's level of modernization, on the basis of fleet age and technology, and for determining the approximate level of RDA funding needed to achieve the Army's long-term modernization goals. The methodology revolves around a system's Refit or Replace (R2) point. This is the age at which a piece of equipment will no longer be mission capable in sufficient quantities, will not have sufficient capability or (in the case of combat systems) will not retain a technological advantage over similar equipment. At each such point in a system's life, a decision must be made on whether to refit (i.e., upgrade) or replace (i.e., buy more of the same or a field a new system). Historically, the R2 point occurs at 8 - 10 year intervals for most systems. The methodology portrays the impact of alternative R2 decisions over time. Modernization decisions made now will continue to impact readiness over the next 20 years.

WG 30 — DECISION ANALYSIS — Agenda

Chair: Samuel (Matt) Vance, McDonnell Douglas
Cochairs: 1st Lt Todd Combs, Wright Labs Flight Dynamics Directorate
Dan Dassow, McDonnell Douglas
Dr. Steve Fought, Naval War College
LtCol Dan Maxwell USA, PhD, Army Concepts Analysis Agency
Dr. Dick Pariseau, Advanced Marine Enterprises, Inc.
Advisor: Col Bruce Smith, USAF, Geophysics Lab
Room: GIF, 358-A&C

Tuesday, 1030-1200 - ***Eliciting and Aiding Operational Decisions:***
Development of a Decision Support System Based on Analysis of Operational Decisions
Susan G. Hutchins, Jeffrey G. Morrison, Richard T. Kelly, Naval Postgraduate School, Ocean Surveillance Center 6310

What is the Value of Destroying a Target?...An Application of Decision Analysis in Support of the Deep Attack Weapons Mix Study
LtCol Dan Maxwell USA, US Army Concepts Analysis Agency

Fragmented Battlefield
Lt Col Philip Coker and Ms. Lisa Disbrow, the Joint Staff (J-8)

Tuesday, 1530-1700 - ***Prioritizing Variables:***

The US Army Modernization Prioritization System (AMPS) and Value Added Analysis (VAA)
LtCol Rodger Pudwill, US Army Concepts Analysis Agency

Quality Function Deployment - Its Not Just For Requirements Anymore!
Joyce Wheeler, McDonnell Douglas Corporation

A Structure for Assessing Priorities in Planning for Information Warfare
Frank Paparozzi, Charlie Heimach, Garret Schneider, Chiang Ren, ANSER

Wednesday, 0830-1000
COMPOSITE GROUP VII . . . . **Bell Hall, Marshall Auditorium**

Wednesday, 1330-1500 - ***Decision Conferencing:***

Optimal Strategies Using Electronic Poling Devices and Decision Analysis Software for Selecting a More Representative Technology Mix
Peter J. Paternoster, National Security Agency

Distributed Decision Conferencing
Steve Hyde, TASC

Leveraging Analysis for Decision Making: What Can Analysis Do?"
Peter T. Tarpgaard, Naval War College

Wednesday, 1515 - 1645 - ***Decision Analysis Seminars:***

Common Decision Analysis Problems When We Practice What We Preach
Facilitator; Matt Vance, McDonnell Douglas Corporation

Dissecting AHP
LtCol Andy Loerch, Office of Chief of Staff, Army

Thursday, 0830-1000 - ***Decision Analysis Seminars (continued):***

Decision Analysis Software Demonstrations; Equity & Logical Decision for Groups
Facilitator; LtCol Dan Maxwell, USA CAA, Peter Beck, Decision Technology and Gary Smith, Logical Decisions

Developing Criteria for Operational Interfaces for Senior Level Professional Military Education War Games
Col David B. Lee, Air War College

<u>Thursday, 1330-1530</u> - ***Technology Evaluation:***

Optimizing Vehicle and Fleet Survivability for the Crusader System
Dr. Roy E. Rice, Teledyne Brown Engineering

Winning with Information Warfare
Chiang Ren, Frank Paparozzi, Charlie Heimach, Garret Schneider, ANSER

The Effects of Future Foreign Military Sales to Saudi Arabia
2LT Robert Renfro, AFIT

WG 30 - DECISION ANALYSIS - Alternates

Testing of Multitrajectory Techniques for Military Simulation
John B. Gilmer Jr., Wilkes University

JMASS: A Maturing Technology for Modeling and Simulation
Capt Phil Lienert, WPAFB ASC / XRE

WG 30 — DECISION ANALYSIS — Abstracts

<u>Tuesday, 1030-1200</u>
Development of a Decision Support System Based on Analysis of Operational Decisions

Susan G. Hutchins, Jeffrey G. Morrison and Richard T. Kelly
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Approved abstract not available at printing

What is the Value of Destroying a Target?...An Application of Decision Analysis in Support of the Deep Attack Weapons Mix Study

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Military commanders engaged in combat care about destroying targets for many reasons. Specific sets of targets may be important to protect military forces and noncombatants. Some targets enable achievement of the CICN's operational objectives, as well as the strategic and political objectives. Many targets support multiple objectives. This paper describes the process and mathematics that were used to identify these objectives, assess the values and beliefs of all key participants, and integrate that information into a cohesive measure that could be applied in other models necessary to the study.

Fragmented Battlefield

Lt Col Philip Coker, Ms. Lisa Disbrow
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Approved abstract not available at printing.

<u>Tuesday, 1530-1730</u>
The US Army Modernization Prioritization System (AMPS) and Value Added Analysis (VAA)

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In the current era of diminished resources, the VAA series of studies addresses the allocation of investment funds to Army modernization. The techniques applied cover a wide range of operations research procedures to include simulation, optimization, and decision theory. A shortcoming of previous iterations of VAA type analysis is the limited number of systems addressed and the restriction to examining fifty percent of the funds available in the analytic models. The AMPS augmentation to VAA extends the prioritization process to address all Army modernization programs.

Quality Function Deployment - Its Not Just For Requirements Anymore!

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Approved abstract not available at printing.

A Structure for Assessing Priorities in Planning for Information Warfare

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This paper describes an application of the Strategies-To-Tasks methodology toward the waging of theater based information warfare (IW). This IW construct is then incorporated into an hierarchical decision making process using the Expert Choice software tool. The IW tree starts from national military objectives and branches down to progressively lower levels of objectives, strategies, and tasks for the JCS and for the CINCs. IW is broken down into offensive, defensive, enabling, and supporting operations. The national-level IW goals are defined as information superiority, faster decision cycle, change national will, impact political control, reduce weapons integrity, impact RDT&E and manufacturing, and jeopardize warfighting. This effort is designed to assist both OSD Net Assessment and the Air Force Headquarters in their IW evaluation and planning. A series of expert-based workshops using this structure will be hosted by ANSER as the next step in this effort.

Wednesday, 0830-1000
COMPOSITE GROUP VII
Bell Hall, Marshall Auditorium

Wednesday, 1330-1500
Optimal Strategies Using Electronic Poling Devices and Decision Analysis Software for Selecting a More Representative Technology Mix

Peter J. Paternoster
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NSA must make technology choices to best support operational requirements. This decision process has been improved by using electronic polling devices to solicit expert opinions as to the value of technology alternatives. The polling results are tabulated and used by computer software to rank order technology alternatives according to their benefit / cost ratios. This paper describes this decision analytic process and documents lessons learned that include: preparation guidelines for polling sessions, criteria for selection of participant to poling device rations, software options that enhance the process, software selection criteria, presentation and facilitation techniques that enable and speed up group participation, techniques for handling large numbers of alternatives, guidelines for selection ad valuing of technology alternatives, guidelines for determining the cost of alternatives, self-documentation process, and documentation format. Two polling and primary evaluation sequences are described. The first includes the use of OptionFinder Package and a software package called Equity. The second sequence uses Saaty's Analytical Hierarchy Methods through his company's software package called Team Expert Choice. The advantages and disadvantages of both sequences are described and criteria are given to select an appropriate sequence dependent on the decision environment and decision space.

Distributed Decision Conferencing

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Approved abstract not available at printing

Leveraging Analysis for Decision Making: What Can Analysis Do?

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Many factors can affect the process of decision making in a complex decision situation. These include personal interests, organizational interest, "political" influences from multiple sources, and a host of other questionable, but very real, factors beyond the legitimate and objective considerations that are the normal province of the analyst. A skeptical perception of real world decisions might conclude that honest analysis is often ignored because of, or overwhelmed by, factors which are not, and should not, be considered in the analysis. This paper reexamines the role of analysis in decision making and suggests that it can play a broader role than has been customary in the past. Starting from a basic framework for decision making, the paper will suggest a broader application of analytic tools -- beyond the normal application of discriminating among the alternatives -- can be very useful in practical decision making. Among these broader applications is the use of analysis in preparation for the "reconciliation" phase of decision making where a decision made at one level must be modified through a process of negotiation in order to be reconciled with other interests affected by the decision.

Wednesday, 1515 - 1645
Open Panel Discussion: Decision Analysis, Common Problems When We Practice What We Preach

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LtCol Andy Loerch
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Program Analysis and Evaluation Directorate
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Potential discussion topics include: 1) What is the typical mapping of decision analysis problems with compatible decision tools? 2) Can someone please explain, in laymen's terms, how AHP

works, or said another way, how do you explain to an Admiral / General that you just used an "eigen vector" to capture his priorities? 3) If you are not using a Multi-Attribute Utility tool, how do you map overarching intangibles like cost and risk into your decision analysis assessments?

Thursday, 0830-1000

Decision Analysis Software Demonstrations: Equity & Logical Decision for Groups

Presenters: Peter Beck, Decision Technology and Gary Smith Logical Decisions

Point of Contact:
LtCol Dan Maxwell
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Advances in the computer and computational sciences have made significant contributions throughout the field of operations research. This is especially true in the field of decision analysis. This session demonstrates some advanced software that is specially designed to assist decision makers (or groups of analysts) in the formulation and analysis of complex multi-attributed decision situations.

Developing Criteria for Operational Interfaces for Senior Level Professional Military Education War Games"

Col David B. Lee
Air War College
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Computer assisted war games have been used in professional military education with some success. One advantage is the possibility of reduced labor requirements during the execution of simultaneous independent exercises. However, computer assisted war games for educational purposes, to date, use a "bottoms-up" approach and become to tedious for students who, at their 18th to 22nd year of military service, need war game exercises at a higher-more aggregate-level. The Air War College in conjunction with the Air Force Wargaming Institute has embarked on establishing the "right" levels of information needed by students to analyze, synthesize and evaluate the higher levels of operational art in warfare. This paper describes our view of educational war games, the use of technology in educational war games and attempts to identify inputs at the operational level.

Thursday, 1330-1530

Optimizing Vehicle and Fleet Survivability for the Crusader System

Dr. Roy E. Rice
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Huntsville, AL 35807-7007; Phone: (205) 726-2038

Combat vehicles will face a wide array of threats on the future battlefield. To counter these threats, we must design treatments and countermeasures into these vehicles that will negate these threats and enhance the probability of survival. These survival measures cover the spectrum of technology from signature management to improved armor to threat warning systems. But each of these measures carries a set of burdens. These burdens are in terms of additional weight, cost, volume, power etc. the problem our requirements analysts and designers face is a classic Knapsack Problem. We have a knapsack that is only so big and can only carry so much "stuff". Our approach and the solutions are driven by the threat that we are likely to encounter. we solve these knapsack problem using a Mixed Integer Program (MIP) which maximizes the probability of survival of a single vehicle in a single expected encounter. The decision variables are which countermeasure treatments to include in the suite being designed into the vehicle to counter the threat. To maximize survivability the model chooses treatments that can counter the specific threats according to quantitative measures of how effective the treatments are at countering the threats. The assignments of the treatments are chosen so that the resulting suite does not exceed established limits on cost, weight, volume, data, and power parameters.

Winning with Information Warfare"

Chiang Ren, Frank Paparozzi, Charlie Heimach, Garret Schneider
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Phone: (703) 416-3096

This paper describes an original methodology for assessing information warfare (IW) capabilities and deficiencies developed by ANSER for the Assistant Secretary of the Air Force for Acquisition, Directorate for Space Programs. The methodology was initially developed from an Nth country to Nth country standpoint. Specific U.S. policies and doctrines are not addressed. Some highlights of this methodology are: 1) a break-down of IW for different phases of hostility ranging from peace to full military engagement, 2) a traceability form top-level IW objectives down to civil / commercial, military sustainment, and combat operation systems that can be attacked in each phase of conflict, 3) a functional break-down of systems from development to execution with identification of IW attack points, 4) an identification of the specific means of attack and targets of attack for each attack point under each phase of conflict, and 5) a method for measuring the impact of specific IW effects toward the overall outcome of a theater conflict using existing combat simulation models such as Thunder. This methodology represents on initial step in ANSER's continuing efforts to assist the Air Force in understanding the nature and impact of IW on current / future systems and in developing innovative acquisition strategies to respond to identified IW needs.

The Effects of Future Foreign Military Sales to Saudi Arabia"

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Saudi Arabia is one of the largest purchasers of U.S. arms. Current conditions place uncertainty on the stability of future sales. These sales promote growth in the U.S. industrial base and raise revenues for U.S. manufactures. Decisions on future sales must balance national security, military and political interests. These decisions fall heavily on the input of U.S. military and federal government decision makers.

WG31 — COMPUTING ADVANCES IN MILITARY OPERATIONS RESEARCH — Agenda

Chair: MAJ William S. Murphy, TRAC-Monterey
Co-chair: MAJ Glenn G. Roussos, TRAC-Monterey
Advisor: MAJ Charles A. Pate
Room: GIF, 353-B

Tuesday, 1030-1200
Live Virtual Simulation for Operational Testing: System Design at Ft. Hunter Liggett
Dr. Wolfgang Baer, Department of Computer Science, Naval Postgraduate School and Mr. Mike Tedeschi, Test and Experimentation Command Experimentation Center(TEC)

A Massively Parallel Implementation of a Readiness Based Sparing Algorithm
Dr. Meyer Kotkin and Mr. Thomas Hagadorn, US Army Materiel Systems Analysis Activity

J-MASS: A Maturing Technology for Modeling and Simulation
William W. Schoening, McDonnell Douglas Aerospace

Tuesday, 1530-1700
Software Issues in Multitrajectory Simulation
John B. Gilmer, Mr. Frederick J. Sullivan, and Mr. Sadeq Al-Hassan, Wilkes University

Aggregation-Disaggregation Using Distributed Interaction Simulation
Mr. Michael Healy, Advanced Telecommunications, Inc.

Application of the IsPurOf (IPO) Protocol Data Unit (PDU) for analytical modeling
Mr. Lawrence A. Rieger, HQ, TRADOC

Wednesday, 0830 - 1000
COMPOSITE GROUP VII SESSION .... Bell Hall, Marshall Auditorium

Wednesday, 1330-1500
Automation of the U.S. Army Materiel Systems Analysis Activity's (AMSAA) Item Level Performance Database
Mr. Shawn G. Roach and Ms. Karen Drude, USAMSAA

Use of a Computer Aided Exercise to Evaluate CINC Staff Training Based on the Universal Joint Task List
Professor Sam H. Parry, Department of Operations Research, Naval Postgraduate School

A Hybrid Expert System for Scheduling the US Army's Close Combat Tactical Trainer (CCTT)
LTC Michael L. McGinnis and MAJ Robert G. Phelan, Jr., Operations Research Center, US Military Academy

Wednesday, 1515 - 1645
Personal Computer Optimum Stockage Requirements Analysis Program (PC-OSRAP)
Mrs. Ruth Dumer, US Army Material Systems Analysis Activity

Designing Software for Windows 95
Mr. Kral Ferch, Sciences Applications International Corporation

Personal Computers and Military Application/ACVAT Example
Dr. Urban H. D. Lynch, UHL Research Associates, Inc.

Thursday, 0830-1000
High Resolution Terrain Representations for Live-Virtual Test Applicants
Dr. Wolfgang Baer and Mr. Chris Reed, Department of Computer Science, Naval Postgraduate School

Soldier Station
Mr. John Galloway, TRADOC Analysis Center- White Sands Missile Range

Improving Computational Efficiency in the Discrete Event Simulation of Non-Uniformly Distributed Autonomous Spatial Objects
MAJ Gary J. Harless, USA Concepts Analysis Agency and Mr. Ralph V. Rogers, Department of Industrial Engineering & Management, University of Central Florida

Thursday, 1330-1500
Rapid Model Prototyping with Event Graphs
Professor Arnold Buss, Operations Research Department, Naval Postgraduate School

A Multisensor Simulation Environment for Sensor Fusion and AT-Analysis
Mr. John P. Doughtie, Amherst Systems, Inc.

Standard Missile Fly-out Model on a Parallel Computer
Mr. Timothy S. Floyd, Electronic Systems Laboratory, Georgia Tech Research Institute

WG31 - COMPUTING ADVANCES IN MILITARY OPERATIONS RESEARCH – Alternate

Experience Implementing a Decomposition Algorithm Using the CPLEX Callable Library
MAJ Leroy Jackson, TRAC-Monterey

WG 31 — COMPUTING ADVANCES IN MILITARY OPERATIONS RESEARCH — Abstracts

Tuesday, 1030-1200
Live Virtual Simulation for Operational Testing: System Design at Ft. Hunter Liggett

Dr. Wolfgang Baer
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Operational force-on-force testing has been connected with Real World Battlefield simulation to provide virtual weapons interaction, situational test control, and after action review and analysis capability. A system design providing connectivity between live test data sources and video realistic, virtual, and constructive simulators through use of the DIS protocol is presented. Target representations and target environment backgrounds are compared between different simulator capabilities. The use of high resolution terrain simulators capable of generating realistic and metrically accurate battlefield views as reality bridge devices between live tests and constructive simulations is discussed. Performance results for the low cost Pentium based networked parallel processing engine under development for the real time interactive perspective view generation is presented. Early virtual reality experiments designed to show the feasibility of mixing live ground troops with notional computer generated weapons systems provide interesting anecdotal experiences which forecast unusual applications for Real World Simulation Technologies.

A Massively Parallel Implementation of a Readiness Based Sparing Algorithm

Dr. Meyer Kotkin and Mr. Thomas Hagadorn
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Readiness Based Sparing (RBS) is a Class IX requirements determination concept that recommends that the supply/maintenance system use the most effective stock lists that support weapon system operational performance targets. Multi-echelon, multi-indenture RBS models such as SESAME are being used regularly to determine/evaluate peacetime and wartime/contingency requirements.

The sizes and scopes of the problems to which RBS models are being applied are rapidly growing. In order to determine/evaluate Army prepositioned stockpiles, a wartime/contingency RBS model was recently run for a three level supply/maintenance system supporting 865 different types of end items with almost 100,000 applications of approximately 25,000 distinct spares. The advent and maturation of massively parallel computer architecture and software provides an opportunity to devise and successfully implement a parallel algorithm for the rapid solution of the large nonlinear integer programs embedded in SESAME. Fast running RBS algorithms will allow for the sensitivity analyses and "what-if" exercises necessary for designing an effective, rapid response logistics system.

In this talk, we will discuss alternative parallel algorithms for solving the RBS requirements determination problem that will be developed and evaluated on the massively parallel IBM SP2 machine at the Army's High Performance Computing Center at the University of Hawaii.

J-MASS: A Maturing Technology for Modeling and Simulation

Mr. William W. Schoening
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The Joint Modeling and Simulation System (J-MASS) provides operations analysts with a single simulation environment

for building, executing, and post processing models and simulations on a UNIX workstation. Models and simulations built in J-MASS can be either real-time or event-based, can include both hardware-in-the-loop and operator-in-the-loop, and operate in a distributed processing mode over a heterogeneous set of computers. This paper provides an introduction to J-MASS using models and simulations currently under development by J-MASS users around country as examples. These examples include aircraft, missiles, radar, global positioning satellites, and infrared systems. Some of the models are being built in Ada and some in C++; models built in either language can be used in the same simulation. In addition, there will be a live demonstration of features and capabilities using models built by J-MASS customers.

Tuesday 1530-1700
Software Issues in Multitrajectory Simulation

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Multitrajectory simulation treats probabilistic events by creating, a simulation state and trajectory for each outcome of a random event, rather than just selecting one outcome of a random event, rather than just selecting one outcome as is done conventionally. In effect, Multitrajectory simulation generalizes the concept of a random number generator to return multiple simultaneous samples, each being a separate future trajectory.

In a research project sponsored by the ~S Army Concepts Analysis Agency and the Army Research Office, Wilkes University has been exploring the issues and benefits of applying multitrajectory sirnulation to rnilitary simulation. This paper reports on the software issues that were identified and solutions developed as part of this project. These include the definition of classes for chooser and random number generator objects which are, in effect, called once, but return multiple times. The management of such events must be encapsulated so that an analyst can read and develop a simulation's functional domain code without having to become enmeshed in Multitrajectory control issues. The policy for the control of Multitrajectory events for example when to treat a given decisionmaking rule firing event with Multitrajectory, stochastic, or deterministic outcome. also needs to be encapsulated separately. These techniques have been implemented in a simple battalion resolution simulation having multilrajectory events for movement, acquisition, decisionmaking, and attrition Additional issues raised by this researcher and not yet resolved will also be discussed.
The mulitrajectory approach may change the way analysis is performed by making control and management of the outcome set probability distribution part of the simulation mechanism.

Aggregation-Disaggregation Using Distributed Interaction Simulation

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Distributed Interactive Simulation (DIS) provides an environment in which entity-level behavior can be simulated in a virtual world, providing a level of entity to entity interaction detail not found in aggregate simulations using abstractions and monte carlo techniques to determine the outcomes of events. A number of linkages have been developed between aggregate simulations and simulations modeling individual entities in a virtual world. This type of linkage could allow an analyst using the aggregate simulation to study finer-grain phenomena. A standard DIS protocol has been developed in facilitate aggregation-disaggregation and the passing of aggregate state data. This Aggregate Protocol is part of the DIS Simulation Management protocols. An extension is being proposed to specify a standard mechanism to allow a Virtual Entity Controller, which could be an aggregate simulation, to instantiate aggregate units into the DIS world using an entity-level simulation to generate the entity-level behavior. This paper describes our past and ongoing efforts in this area.

Application of the IsPartOf (IPO) Protocol Data Unit (PDU) for analytical modeling

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The IPO PDU is developmental PDU under DIS Standards 2.1.4 (DRAFT). Originally developed with a focus on munitions carried aboard aircraft, it is currently being developed under an Army SIMTECH project as a means of pseudo-aggregation for bandwidth reduction during multi-site DIS training exercises. As a means of pseudo-aggregation, the IPO PDU also has application to the analytical modeler permitting virtual environment generators to be used at numerical force levels usually only modeled in constructive environments.

Analytical modeling is usually performed in either the virtual or constructive environments. Virtual environment modeling provides the lowest level of entity resolution and permits recording and analysis of complete subject actions within the model. Virtual modeling is restricted technically by the number of entities will drive CPU requirements above work station capability to mainframe computer. Constructive models permit analysis of large scale populations, but are restricted either to engagement resolutions performed at the aggregate level, with resulting loss of detail for the analyst, or demands de-aggregation and re-aggregation of model entities, with resulting large CPU processing capability.

The IPO PDU permits single unit groupings of entities, or pseudo-aggregation, while retaining entity level detail for the analyst. Through the IPO grouping, work station CPUs can model units at constructive force levels while retaining the advantages of the virtual environment. The paper discusses the applications of the IPO PDU to modeling, including Entity State Update PDU data fields descriptions and decision rules for entity management and aggregation/de-aggregation.

Wednesday, 0830 - 1000
COMPOSITE GROUP VII SESSION
Bell Hall, Marshall Auditorium

Wednesday 1330-1500

Automation of the U.S. Army Materiel Systems Analysis Activity's (AMSAA) Item Level Performance Database

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The U.S. Army Materiel Systems Analysis Activity has the mission of providing item level performance estimates to a wide variety of customers across the Department of Defense (DoD). To better service these customers, AMSAA is improving it's information management procedures with regard to data standardization and automation. Specifically, AMSAA is developing a single integrated relational database which will incorporate all of the AMSAA item level performance data, as well as data generated by the Joint Technical Coordinating Group for Munition Effectiveness (JTCG/ME). This will allow both organizations to share common data and eliminate redundancies. The database will standardize the common tasks and data elements across each of the functional areas (Artillery, Armor, Air Defense, etc) within AMSAA. Emphasis is on the integration and improvement of functional area processes and models (utilizing standard nomenclature, developing generic data screening tools, validation of data, etc), the development of a user friendly database access menu system, and the migration of data from legacy AMSAA and JTCG/ME databases. This integrated database system will improve AMSAA's data management processes by fully automating such tasks as: bulk loading model output, generation of reports for management review, generation of reports in customer specified formats and quality checking of data. Customers will benefit from quicker responses, standardized data elements and standard file structures. The development of the database and loading of the item level performance data is scheduled to be completed 25 April 1996.

Use of a Computer Aided Exercise to Evaluate CINC Staff Training Based on the Universal Joint Task List

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This presentation describes a continuing research effort to develop a methodology for evaluating tasks performed by a joint staff as set forth in the Universal Joint Task List ~UJTL). Measures of effectiveness are defined for several functional areas. Automated data collection procedures from the Joint Theater Level Simulation ~JTLS~ are implemented, with emphasis on providing the staff planner with an ability to associate causal reasons for significant events in an actual CINC exercise.

The Universal Joint Task List, a supplement to the Joint Training Manual, is a comprehensive listing of all joint tasks pertaining to the Armed Forces of the United States. Tasks are defined as they relate to the strategic, operational, and tactical levels o~ war. This research, initiated in October, 1994, develops an exercise analysis methodology for evaluating CINC staff f performance in the execution of joint tasks during the conduct of a Computer Aided Exercise (CAX). Research during CY 1995 resulted in analysis of data from JTLS runs for the sustainment and intelligence strategic tasks which demonstrated the usefulness of the developed methodology. Initiated in July, 1995, current thesis s research by six NPS students is focused on the areas of ground maneuver forces, protection of high value assets (both land and sea based), prosecution o£ enemy high value targets, amphibious operations, and force deployment. Results from INTERNAL LOOK ~6, a USCENTCOM exercise in March, 1~96, and three weeks o~ controlled experimental runs using JTLS will provide the data for demonstrating developed methodologies.

This presentation will present results developed over the past Year and provide an overview of anticipated future results.

A Hybrid Expert System for Scheduling the US Army's Close Combat Tactical Trainer (CCTT)

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With the end of the Cold War, the US Army shifted from a forward deployed force that, for nearly fifty years, mostly trained for a conventional, highly mechanized war in central Europe to a more centrally-based force responsible for a substantially broader range of military operations potentially occurring in any theater with little or no warning. These new challenges, combined with force structure downsizing and defense budget cuts, forced the Army to research new, innovative approaches training. In turn, these efforts led to the concept of a family of high technology, computer-based training facilities called the *Combined Arms Tactical Trainer (CATT).* The first of these to be developed is the *Close Combat Tactical Trainer (CCTT)* facility; a synthetic, computerized environment for training armored and mechanized forces at battalion and below. The major tasks for planning a days' training include: (1) selecting scenarios for training; (2) scheduling the scenarios throughout planning horizon where multiple scenarios may be scheduled simultaneously; and (3) scheduling the type and quantity of training resources for conducting each scenario where resource quantities vary by scenario type and may vary within a scenario type as well. CCTT training resources include manned simulator modules, computer workstations, workstation operators (people), and computer generated, semi-automated forces (SAF). This report discusses the development of a hybrid expert system for selecting training scenarios, and scheduling training scenarios and a single resource for each scenario, namely, Semi-automated forces, via heuristic procedures.

Wednesday 1515 -1645

Personal Computer Optimum Stockage Requirements Analysis Program (PC-OSRAP)

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This Army Materiel Systems Analysis Activity (AMSAA) has developed stock optimization methodologies to support

various ASL/PLL planning scenarios. The Readiness Based Sparing Model (RBS) provides Authorized Stockage Lists (ASL) in a peacetime environment. RBS uses historical unit demand data and optimizes on cost to provide requirements objectives for Class IX items. The Optimum Stockage Requirements Analysis Program (OSRAP) provides requirements objectives for Class IX items in support of wartime/contingency planning. The OSRAP uses the Candidate Item File (CIF) developed by the Major Subordinate Commands (MSCs) and combat damage data from the Sustainability Predictions for Army Spare Components Requirements for Combat (SPARC) as input in to model.

The PC-OSRAP was designed to enable the distribution of the mainframe FORTRAN programs, OSRAP and RBS, to PC users. PC-OSRAP uses object oriented programming tools, in the form of a graphical user interface (GUI), to provide a user friendly model that incorporates both methodologies to determine optimum stock lists.

PC-OSRAP was written with Visual Basic 3.0, in the Windows 3.1 environment. It has multi-media applications, to include, Bit Map Pictures (BMP), sound or WAV files, in-screen video, AGI files, database access to DBASE III, DBASE IV, and ACCESS files. Most of the features of PC-OSRAP was accomplished with the tools included in Professional series of Visual Basic 3.0 with a few add-on VBX routines. The optimizing methodology routines were written in FORTRAN and complied for the PC. These files are accessed via a windows handler and a SHELL command.

Designing Software for Windows 95

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The Automated Test Planning System (ATPS) is a set of expert system-based software tools initially developed for OUGD(A&T)/DTSE&E staff officers to assist with the Test and Evaluation Master Plan (TEMP) review process. Since its successful introduction in 1993, DTSE&E, in collaboration with the Sciences has grown the ATPS to also encompass T&E program risk assessment and TEMP development.

This presentation will cover the evolution of the Automated Test Planning System (ATPS) from a 16-bit Windows 3.1 application to a 32-bit applications targeting Windows 3.1 with Win 32, Windows 95, Windows NT, and the Macintosh. It will be given from the software designer's perspective. The presentation will cover some of the reasons why the 16-bit ATPS architecture was outgrown. The following areas of Windows 95 application design will be discusses.

. Document centered Architecture
. Windows 95 Common Controls
. OLE Drag and Drop
. Simple MAPI

Personal Computers and Military Application/ACVAT Example

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The technology of personal computers(PC) is ever increasing and providing very cost effective computer power that in the past was only found in mainframe or workstation computers This burgeoning PC technology affords a new cost effective capability with ability to replace old outdated computer systems having limited flexibility Furthermore, the same PC technology is available in portable laptop versions that allows very complex data/graphic presentations at home, in the office, briefing room, class room, on travel, at conferences and operational training/combat situations Although the major PC software developers have provided ample applications for home and business, the use of PC technology to meet military operational needs will only come in time The Air Combat Visualization and Analysis Tool(ACVAT) is an example military application *graphical user interface* software, designed specifically for PC/laptop computers, heretofore only residing in fixed-base computers ACVAT will be presented (with a laptop computer and electronic interface to expanded computer screen or overhead interface) as an example to show its graphical user interface applicability to

* Engineering analysis
* Air combat operational model verification and validation
* Air combat operations analysis
* Air combat training, etc.

<u>*Thursday 0830-1000*</u>
High Resolution Terrain Representations for Live-Virtual Test Applications

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Virtual environments of terrain areas for use in Real World Battlefield simulation applications require large data bases to provide earth surface realism. The 2.5D Voxel approach provides a compact data storage and rapid playback mechanism suitable for these applications. A comparison between 3D Voxel, 2.5D Voxel and Polygon data bases shows criteria of selection for each of the formats depends upon the data-to-view resolution ratio and the level of realism desired. A suitable world database structure capable of providing world wide terrain backgrounds is discussed. Standard data source initialization tools and local data information updating tools available to support rapid terrain generation for video realistic battlefield simulation are presented. Lastly we present a case study of data base creation tools and formats used to generate a 2 Gbyte ground characterization of Ft. Hood, Tx.

Soldier Station

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Experiments such as the Task Force X~ Advanced Warfighting Experiment are investigating the fighting structure of

the future US Army and will demonstrate the increases of force effectiveness that can be gained by "digitizing" the force The digitization will reach all facets of the Army to include the dismounted soldier With the digitization being available to the dismounted soldier, increased situational awareness will be available to higher levels of command. The commander will be able to reorchestrate the battle by sending digital information down to the soldiers quickly and accurately Present and future conflicts appear to be moving towards multiple contingence operations, and low intensity operations New tools and innovative methods of analysis are needed to explore this new environment The Soldier Station will be able to answers these issues.

The Soldier Station has been built to analytic standards, verified and validate during development and transferable both to a virtual soldier and through feed back loops to constructive simulations. It is a bridge between the two forms of simulations. The Soldier Station is DIS compatible and will run in real time across the net. The proof of principle of the Soldier Station lies in the direct interaction through visual stimuli with aural accompaniments and enhanced communication The visual portion, the 3-D view of the terrain as seen the eyes of the soldiers, aural through the use of stereo speakers and communications through the digital transfer of situational reports and voice communications The linkage of the Soldier Station to the constructive models and simulators provides the actual parameters representing postures and movement, engagements of individual weapons, and vulnerability of the soldier to an environment.

Improving Computational Efficiency in the Discrete Event Simulation of Non-Uniformly Distributed Autonomous Spatial Objects.

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Current discrete-event simulation methodologies face difficulties in achieving the explicit portrayal of autonomous spatial object movement and interaction. Autonomous spatial movement and interaction can be achieved by comparing each individual spatial object against all other spatial objects occupying the same trajectory space. To reduce the number of comparisons required to determine the next event of interest the trajectory space can be sub-divided into sections of equal size. However, when spatial objects are non-uniformly distributed sectors of equal size may fail to provide increased efficiency.

This research focuses on the development of an efficient discrete-event simulation methodology for simulating systems characterized by the spatial movement and interaction of numerous non-uniformly distributed autonomous spatial objects. The efficiency of this proposed methodology is achieved during the running of the simulation by sub-dividing and consolidation sectors based on the current distribution of partial objects.

Comparison testing demonstrated that the purposed methodology can provide a significant decrease in men computer execution time while simulating a non-uniform distribution of spatial objects.

Thursday 1330-1500
Rapid Model Prototyping with Event Graphs

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Abstract: Discrete 3~vent Simulation (DES) is a very useful paradigm for modeling a wide class of systems. Focusing only on actions that are important to changing the state of the system can produce a more parsimonious and efficient model than time-step simulations. Event Graphs are a powerful ~ visual tool for designing, constructing, and implementing DES models. The methodology is extremely compact, involving only two basic constructs and a handful of options. This simplicity facilitates extremely rapid construction of small- to medium-sized DES models, in turn speeding up the development cycle through the use of prototype models.

No modeling power is sacrificed by the simplicity of the paradigm, however, since Event Graphs may be shown to be equivalent to Turing machines. The modeler is afforded much flexibility with Event Graphs. For example, a Lanchester model may be readily combined with an Event Graphs scenario. Being simple, graphical, and visual, Event Graphs are also an ideal way to teach DES methodology, and have been used in the basic simulation course at the Naval Postgraduate SChOO1 for several years. A commercial package, Sigma, which implements Event Graph methodology in a Windows environment, will be used to illustrate the capabilities of Event Graph Modeling.

A Multisensor Simulation Environment for Sensor Fusion and AT~ Analysis

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A modular software simulation system has been developed for the evaluation and optimization of integrated FLIR/Ladar automatic target recognition (ATR). This system includes a scenario model that accommodates clutter and moving targets and platforms, a FLIR sensor model a newly developed first-principles ladar sensor model, a sensor manager system that allocates ATR resources (e.g..., gaze and scan control), and an automated performance optimization system that iteratively adjusts both sensor and ATR algorithm n parameters. This system is in ended for the evaluation of Air Force FLASER and directed vision concepts.

A registered model database represents both the IR and ladar scenarios, from which wide-area search FLIR imagery is generated with the GTVISIT IR modeling package. An IR cueing algorithm generates ladar gimbal and scanner pointing comrnands. The ladar model renders the cued target region, where effects of platform, target, and ladar beam scanning motion are accurately represented. Coherent AM and FM ladar receiver models produce high-fidelity range, intensity. and Doppler image channels. Special emphasis was placed on modeling correctly those pixels at target edges and

other range discontinuities since many ladar ATR algorithm attempt to exploit the information in these regions. Examples of synthetic collocated IR and ladar imageries are presented.

Standard Missile Fly-out Model on a Parallel Computer

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This paper presents a parallel computer hosting a standard missile fly-out model for the generation of multiple missile fly-outs during a flight test mission. Some threat simulators on open-air ranges have integrated missile fly-out models used to simulate the firing of actual missiles. During a flight test mission only one to four missile fly-outs can be accomplished per encounter. As a result, post-test analysis must be conducted to determine ECM effectiveness by generating multiple missile fly-outs to produce miss distance statistics. Generally, these test results are not available for several days after the flight test mission. Oftentimes, subsequent flight test missions are flown without knowledge of ECM technique effectiveness. The unavailability of effectiveness data prior to subsequent flight test missions drastically impacts testing efficiency since any needed corrections or reprogramming of ECM techniques cannot be identified. This results in increased cost since additional missions must be flown to replace inaccurate data.

A standard missile fly-out model has been hosted on a parallel computer network of Transputers and installed at the SADS VIII R test site on the Electromagnetic Test Environment (EMTE) open-air test range at Eglin AFB, Florida. The configuration of Transputers allows for multiple missile launches during an encounter (> 20). The parallel computer receives target data from the test site, simulates multiple missile fly-outs, and produces miss distance statistics in real time. These miss distances are used to show ECM effectiveness during the flight test which allows for more productive testing since the results are known during the test.

WG 32 — ADVANCED ANALYSIS, TECHNOLOGIES AND APPLICATIONS — Agenda

Chair: Mark Axtell, Veda Inc.
Cochair: Molly McKenna, Veda Inc.
Advisor: Maj Robert G. Phelan, USMA
Room: GIF, 354-A

Tuesday 1030-1200
Lanchester Leveraging Technology
Michael W. Garrambone, Major, Army (Ret.), Veda Incorporated

Design of Experiments applied to Prairie Warrior and other AWEs
Robert V. Ewers, Cadet, David H. Olwell, Major, USA, Asst. Prof. and Nathaniel Peters, Cadet, USMA

An Adaptive Feedback Compensation Technique for Improving the Performance of Distributed Adaptive Routing Systems in Datagram Packet-Switched Communications Networks
Arthur S. Olsen, United States Army Material Systems Analysis Activity, AMXSY-CA

Tuesday 1530-1700
Warfighting Analytical Support to Third US Army (WAS-TUSA)
LTC Wm. Forrest Crain, US Army Concepts Analysis Agency

Attack, Passive, Active, BMC4I Pillar Integration (APAB-PI)
Karssten G. Engelmann, US Army Concepts Analysis Agency

Wednesday 0830-1000
COMPOSITE GROUP VII SESSION .... **Bell Hall, Marshall Auditorium**

Wednesday 1330-1500
Considerations Necessary to Develop Valid Disaggragated Entity Based Simulation Federations
Lester A. Foster III, Ph.D., SRS Technologies, Inc.

United States Atlantic Command (USACOM) - Modeling and Simulation in Support of Joint Training for Unified Endeavor (UE) 96-1
LCDR Clarence Todd Morgan, US Atlantic Command (USACOM) Joint Training, Analysis and Simulation Center (JTASC)

Wednesday 1515- 1645
Joint Engagement Technology Study (JETS) with DIS Network
William F. Williams and George T. Cherolis, BDM Engineering Services Company

82nd Airborne Division OPLAN Analysis - Planned Invasion of Haiti 1994
LTC John R. Ferguson, USATRADOC Analysis Center - White Sands Missile Range, NM

Thursday 0830-1000
Warfighting Lens Analysis (WFLA) 98-12 Force Package Analysis
CPT(P) Thomas M. Cioppa, TRADOC Analysis Center -Study and Analysis Center (TRAC-SAC)

Army National Guard Reduces Simulator Operating Costs with Optimization Models
Philipp A. Djang USATRADOC Analysis Center - White Sands Missile Range, NM

Thursday 1330-1500
Recent Technological Advances in the Theory of Volley Fire
Dr. Robert L. Helmbold, US Army Concepts Analysis Agency

An Algorithm to Optimize Satellite Sensor Aimpoints
Dr. Urban H.D. Lynch, Rockwell International Space Systems Division

Tuesday 1030-1200

Lanchester Leveraging Technology

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In 1907 a British automotive and aeronautical engineer published the results of his investigations on the military applications of aviation at a time when flying had only just been proven possible. This individual's theories stand today as the cornerstones of "equations of combat" and are considered to be amongst the most valuable analytical contributions to the art of war. But to those who have been terrorized by the academic references or rely on his equations (the algorithms which drive the attrition processes in our many-on-many combat simulation models) a description of Lanchester's actual thoughts have never really been presented. Despite the numerous references and devilish derivations based on his famous equations, we have lost out on the mindset and content of Lanchester's basic work and how he leveraged technology to bring about a new "Air Arm" to warfighting. The paper discusses the then (1917) envisioned strategic and tactical uses of airpower, weapon effectiveness analysis, and issues in reconnaissance strategic and tactical uses of airpower operations. It discusses Lanchester's concepts on aviation command, control, and logistics; the national and political implications associated with airpower development; and one man's vision on the importance of battle space dominance.

Design of Experiments applied to Prairie Warrior and other AWEs

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Is it possible to make valid statistical inferences based on AWEs? Current practice does not seam to include randomization, blinding, controls, or replication. Inference based on AWEs is, accordingly, subjective at best. The authors report on the results of consulting work they did for the Army Research Laboratory's Human Research and Engineering Directorate to improve the design of AWEs. In their paper, the authors examine a design which works within the existing Prairie Warrior framework, yet allows for replication, randomization, controls, and blinding. The authors report on their experience applying portions of their design to Prairie Warrior 96 and their initial results. They further advocate that fundamentals of design of experiments be extended to all facets of AWEs.

An Adaptive Feedback Compensation Technique for Improving the Performance of Distributed Adaptive Routing Systems in Datagram Packet-Switched Communications Networks

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Contemporary distributed adaptive routing systems for datagram packet-switched networks exhibit poor stabilization and convergence properties at moderate offered loads without the addition of experimentally determined Bertsekas Additive Bias Factors. Unfortunately, while use of Bertsekas Additive Bias Factors improves system stability, it also reduces the sensitivity of the routing system to network congestion. This analysis was motivated by a search for adaptive feedback compensation techniques which improve routing system stability without introducing a loss of congestion sensitivity and which self-optimize for current network conditions. A distributed collaborative update policy was developed which places constraints on the number of allowed routing state changes so as to tune adaptive jumps to the correlation length of the performance surface, the Kauffman Criteria for optimal adaptation. Through simulation, it is demonstrated that the improved routing system avoids the Kauffman Complexity and Eigen Error Catastrophes observed in underbiased and overbiased routing systems, respectively. Above moderate offered loads, up to a 20% increase in throughput and a four-fold reduction in average packet delay is observed with the update policy enhancements.

Tuesday 1530-1700

Warfighting Analytical Support to Third US Army (WAS-TUSA)

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Today's technology conceptually places many analytical tools literally in the warfighting commander's ruck sack. From deployment analysis to analysis and comparison of courses of action - computer assisted warfighting analytical support is here and now. A joint effort between the Third US Army (TUSA)/US Army Central Command (ARCENT) and the US Army Concepts Analysis Agency (CAA) has made this concept a reality. The program is designed to provide a deployable, on-site, responsive, real time analytical support capability for the planning and conduct of combat operations. After initial testing at ROVING SANDS (April 1995), this capability was deployed and fully incorporated

with ARCENT headquarters during BRIGHT STAR 95. During BRIGHT STAR 95 exercise, the team demonstrated this analytical support capability with resounding success. ARCENT integrated this support capability to examine courses of action during the planning process, project branches and sequels to ongoing operations and to serve as a command post exercise (CPX) driver. The DAST typically was able to take a course of action from the ARCENT planners, conduct pre-processing - combat simulation - and post processing analysis, and provide a presentation quality decision graphics brief in 2-3 hours. WAS-TUS has clearly placed the warfighting analytical support capability in the operational commanders ruck sack.

Attack, Passive, Active, BMC4I Pillar Integration (APAB-PI)

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The purpose of APAB-PI is to evaluate the combination of each pillar of theater missile defense (TMD), as well as an integrated TMD on the theater-level campaign. APAB-PI accomplishes this by applying the techniques of dynamic modeling to a low-resolution theater-level model. Instead of focusing on the effects of a single strike, APAB-PI examines the entire campaign. APAB-PI is used in sensitivity analysis, value added type of analysis, and wargame support.

Wednesday 0830-1000

COMPOSITE GROUP VII SESSION
Bell Hall, Marshall Auditorium

Wednesday 1330-1500

Considerations Necessary to Develop Valid Disaggragated Entity Based Simulation Federations

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The potential of using disaggragated entity based simulations appears to be undefined or too hard a problem to solve for many people in the modeling and simulation community. However, a taxonomy to characterize fidelity for this type of simulation has been created and defines boundaries of the capability for disaggragated entity based simulations. The purpose of this paper is to show a developer of modeling and simulation, the considerations necessary to create a valid simulation based upon desired goals and objectives. The paper reviews the DoD High Level Architecture (HLA) simulation federation development process in parallel with the DIS 9 step exercise verification, validation and accreditation process. The paper discusses considerations necessary each step of the way through these processes. Included in the paper are discussions of fidelity and how it affects model type and selection to appropriately represent the phenomena in simulation. By following the methods and procedures described in this paper to create a verifiable and valid simulation, the customer of simulation can take advantage of the benefits disaggragated simulations have to offer. These benefits include proper causal sequences of events, high resolution descriptions of events and interactions, proper implementation of tactics, techniques and procedures, and physics or reality based models.

United States Atlantic Command (USACOM) - Modeling and Simulation in Support of Joint Training for Unified Endeavor (UE) 96-1

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UE 96-1 was a distributed simulation exercise using the JTASC and Joint Warfighting Center (JWFC) which provided the simulation remotely to Ft. Campbell, KY; Moody AFB, GA; and Camp Lejeune, NC. A Northwest Africa NEO scenario with USCINCEUR acting as the supported CINC and USCINCACOM acting as the supporting CINC provided the basis for the exercise. UE 96-1 proved fruitful ground for furthering exercise design concepts, exercise control requirements, and identifying necessary simulation model enhancements. This presentation reviews UE 96-1's planning, requirements, execution, and resulting after action issues by highlighting the current use of models and simulations to facilitate joint training.

Wednesday 1515 - 1645

Joint Engagement Technology Study (JETS) with DIS Network

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The Cooperative Engagement Capability (CEC) was developed by the Navy to use raw sensor track information from various ships and aircraft in a Navy battle group to derive an integrated air picture. This best derived air picture is then shared by all networked units. The improved accuracy and timeliness of the air picture provided by CEC allow a rapid and effective response to high-speed threats like cruise missiles and theater ballistic missiles. JETS will investigate the impact of integrating naval air defense capabilities in a joint force air defense architecture by incorporating an AWACS with CEC into a naval battle group network. The primary means for tactical information exchange will be Link-16 and the Tactical Information Broadcast System. This presentation will cover the establishment of the extensive distributed simulation architecture and data collection needed for JETS. DIS 2.0.4 protocols will be used to integrate

simulations from the above facilities to create a virtual Joint warfare environment. Within this environment various air defense scenarios will be used to measure the performance of a Joint force using alternative capabilities (AWACS without and with CEC) in conducting air defense operations.

82nd Airborne Division OPLAN Analysis - Planned Invasion of Haiti 1994

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During the deliberate planning process for their planned invasion of Haiti in the summer of 1994, the commander of the 82nd Airborne Division solicited support from the US Army TRADOC Analysis Center - White Sands Missile Range (TRAC-WSMR), to use their combat simulation technology to assist them in analyzing, refining and validating their OPLAN. TRAC-WSMR formed a team consisting of military and civilian analysts and used the Janus simulation to represent and analyze the OPLAN. The commander was interested in the outcome of the various fights in each of the three brigade areas of operation and the development of tactical and operational insights into each fight. Representatives of the division G2 and G3 staffs provided the TRAC analysts with the data necessary to represent the OPLAN in Janus. The G2 provided the threat representation based on their IPB and the G3 provided the concept of the operation, map sheets and overlays for each of the three brigade areas of operation. Scenarios were created in Janus that allowed for the combat interaction as specified in the OPLAN. As each scenario was played, the analysts carefully evaluated the cause and effect relationships in each of the battles to the commanders and staffs for the purpose of validating planning figures, force apportionment, weapons allocation, synchronization and tactics. A detailed briefing and Janus battle playback was presented to the division and brigade commanders and their staffs two weeks prior to the invasion date.

Thursday 0830-1000

Warfighting Lens Analysis (WFLA) 98-12 Force Package Analysis

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EFFORT (Early Entry Force Tailoring Tool) is a mathematical optimization application incorporating lethality, survivability, deployability, sustainability, and tempo constraints to mathematically optimize a force package or determine the deviations from goals of a desired force. During optimization, a multi-objective linear goal programming formulation is encoded into the General Algebraic Modeling System (GAMS) and subsequently solved via a mixed-integer optimization algorithm. EFFORT uses fuzzy set theory and simulation techniques (stochastic variability) to capture the synergistic effects of various combinations of units. Each force package was analyzed independently in a SWA (Southwest Asia) and NEA (Northeast Asia) scenario using EFFORT. A comparison is made between the force packages.

Army National Guard Reduces Simulator Operating Costs with Optimization Models

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Between now and the year 2000, the US Army will field 21 high-fidelity mobile networked tank and infantry fighting vehicle training simulators called the Mobile Close Combat Tactical Trainer (M-CCTT) to Army National Guard and Reserve Component. Each Mobile CCTT (M-CCTT) consists of a number of simulator vans (networked computers), a maintenance van, and a generator trailer for a total of 6 (armor) to 7 (infantry) tractor trailer vans.

Our approach consists of sequentially solving a number of combinatorial optimization models. First, we solve a p-median type model to determine where best to home-base the each M-CCTT. The solution allocates armories to home-bases and identifies which armories are farther away than a maximum travel distance criterion. In order to train these units, a M-CCTT will have to travel to an armory to conduct training. To select armories and determine efficient routes, we formulate and solve a new vehicle routing algorithm called cycle cover. The algorithm requires solving multiple set cover and traveling sites and determines the shortest route. From a practical point, a M-CCTT will travel to a number of secondary training sites, where it will rendezvous with nearby units to provide training and then return to home-base. We transposed our location and routing solutions onto US maps so that they become an easy-to-grasp visual decision tool. Our solution were reviewed and approved by the Army National Guard Bureau and the Systems Manager - Combined Arms Tactical Training. The solution is the basis for the fielding plan and contract renegotiation.

Thursday 1330-1500

Recent Technological Advances in the Theory of Volley Fire

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Volley fire occurs when all of a battery of weapons fires simultaneously at a target array. Such volley fire situations are important because they provide a means for estimating the synergistic effects of multiple weapons against a complex target system. Volley fire occurs in many realistic military situations, and can often be used as a reasonable approximation in others. For this reason, volley fire models have been used in a wide variety of military operations analyses.

This presentation will review the main aspects of the historical development of volley fire theory, describe some of its most interesting aspects, provide solutions for several of the more commonly used volley fire models, and illustrate their applications to realistic problems military analysts face every day. Full references

and citations to the literature will provide listeners with the detailed mathematical methods used and suggestions for further research in the theory of volley fire.

An Algorithm to Optimize Satellite Sensor Aimpoints

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The operational tasking of a satellite sensor to produce coverage of a defined Earth target geometric area is a problem common to many satellite data collection systems. Variables of importance include satellite/Earth target relative geometry/dynamics that yield a time-window of opportunity, sensor footprint size/shape and orientation, Earth/target size/shape and orientation, etc. The variables are numerous enough and sufficiently complex in interaction that an aimpoint solution that works well in one case, often does not work well for a wide variety of cases. A satellite sensor aimpoint solution algorithm was desired that would embody sufficient intelligence to work well (be robust) under a variety of geometric/dynamic conditions in reasonable computational time. An algorithm was designed that employs the two classic optimization techniques of *random search* and *gradient* in a way that the two techniques support one another to produce an *optimized* aimpoint solution under robust conditions. The paper presents the basic aimpoint solution algorithm and results of sample satellite/Earth target engagement situations. The emphasis of the effort is on mathematical optimization techniques and how they were designed to produce a robust algorithm.

WG 33 — MODELING, SIMULATION & WARGAMING — Agenda

Chair: Mr. Stephen L. Packard, Oak Ridge National Laboratory
Cochair: Mr. Michael Garrambone, VEDA, Inc.
Cochair: Mr. John Winkelman, Lockheed Martin
Cochair: LTC James R. Wood II, U.S. Army TRAC-Monterey
Cochair: Mr. Charles Venable, VEDA, Inc.
Advisor: Dr. Sam Parry, Naval Postgraduate School
Room: GIF, 358- B & D

Tuesday, 1030-1200
The Evolution of the Model-Experiment-Model Paradigm in Advanced Warfighting Experiments
LTC Patrick Vye, TRADOC - RAND

Attaining Interoperability between ModSAF and JANUS
MAJ Glen Roussos, TRADOC Analysis Command - Monterey

Space Play in Theater Models
LtCol Jack Jackson, Maj Lee Lehmkuhl, & Capt Robert Payne, AF Institute of Technology

Tuesday, 1530-1700
Enhanced Modeling Techniques for Simulation of Evolving Technologies
Mr. Kevin Young, TRADOC Analysis Center - White Sands

Building a Data Warehouse for Modeling and Simulation
Mr. Frank Simura, IMAG, OSD / PA&E

New Strategy for Verification, Validation, & Accreditation
Ms. Priscilla Glasow, Defense Modeling & Simulation Office

Wednesday, 0830-1000
COMPOSITE GROUP VII SESSION .... **Bell Hall, Marshall Auditorium**

Wednesday, 1330-1500
An Evaluation Program for the Intelligent Minefield System
LTC John A. Marin and Professor Donald R. Barr, USMA

Effects of Simulating Crew Coordination in Armored Fighting Vehicles
Mr. Kevin Young & Mr. Peter Shugart, US Army TRADOC Analysis Center

Trade Study Analysis Using Training Simulations: Combat Service Support Training Simulation System Case Study
Mr. Allen T. Irwin & Dr. Linda Beckerman, Science Applications International Corporation

Wednesday, 1515 - 1645
An Evaluation Program for the Intelligent Minefield System
LTC John A. Marin and Professor Donald R. Barr, USMA

Results of USCINCPAC/Naval Postgraduate School Workshop on OOTW Analytic Models
Maj Ross Roley, HQ USCINCPAC and Dr. Dean Hartley III, Oak Ridge National Lab

Testing of Multitrajectory Techniques for Military Simulations
Mr. John B. Gilmer, Jr, Wilkes University

Thursday, 0830-1000
Quantitative Analysis of OOTW
Mr. Robert Osterhout & Mr. Shaun Conlen, Simulation & Analysis Center OSD PA&E

Joint Countermine Operational Simulation (JCOS) After-Action and Reporting System
Mr. Joseph Manzo & Mr. Jeffrey Opper, The MITRE Corporation

Developing Criteria for Operational Interfaces for Senior Level PME War Games
COL David Lee, Air War College

<u>Thursday, 1330-1500</u>
Extending Air Defense into Vector-in-Commander
MAJ Michael L. Boller, TRADOC Analysis Center - Operations Analysis Center

Ardennes Campaign Simulation
Mr. Walter J. Bauman, US Army Concepts Analysis Agency

Representing Information Warfare in a Corps Level Combat Model
LTC Robert Alexander, US Army Concepts Analysis Agency

ALTERNATES

Attack, Passive, Active, BMC4I Pillar Integration
Mr. Karsten G. Engelmann, US Army Concepts Analysis Agency

82nd Airborne Division OPLAN Analysis - Planned Invasion of Haiti 1994
LTC John R. Ferguson, TRADOC Analysis Center - White Sands

USACOM - Modeling & Simulation in Support of Joint Training for Unified Endeavor 96-1
LCDR Todd Morgan, US Atlantic Command - JTASC

Lanchester Leveraging Technology
Mr. Michael Garrambone, Veda, Incorporated

An Adaptive Feedback Compensation Technique for Improving the Performance of Distributed Adaptive Routing Systems in Datagram Packet-Switched Communications Networks
Mr. Arthur S. Olsen, US Army Material Systems Analysis Activity

Joint Engagement Technology Study (JETS) with DIS Network
William F. Williams, SRC/BDM Contractor (Theater Air Command and Control Simulation Facility)

Lessons Learned and Applied in Building an ADS Infrastructure
Hal Meisterling, SRC/BDM Contractor (Theater Air Command and Control Simulation Facility)

JETTA -- Is DIS Ready for the Analyst?
Michael Gray, SRC/BDM Contractor (Theater Air Command and Control Simulation Facility)

Warfighting Analytical Support to Third US Army (WAS-TUSA)
LTC William Forrest Crain, USA Concepts Analysis Agency

WG 33 — MODELING, SIMULATION, & WARGAMING — Abstracts

<u>Tuesday, 1030 - 1200</u>
The Evolution of the Model-Experiment-Model Paradigm in Advanced Warfighting Experiments

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The Model-Test-Model (MTM) concept has been around for at least seventeen years. MTM was originally used in Operational Test and Evaluation (OT&E). In the pre-test modeling phase simulators were used to design, develop and refine test scenarios. The field test provided only a partial representation of the total operational environment. In the post-test modeling phase the results from the test were input into a simulation in order to verify and validate a simulation that augments and expands the scope of the test.

With the advent of Distributes Interactive Simulation (DIS) the MTM concept has evolved so that operational testing has been replaced with virtual environments. The concept has thus become Model-Experiment-Model (MEM). In this case pre-test modeling is used to develop scenarios for use in virtual experiments. These experiments are used with virtual manned simulators. The post-test experiments are used to expand the scope of the few virtual runs.

In recent Advanced Warfighting Experiments (AWE) MEM has again taken on new meaning and emphasis. Experiments no longer involve a handful of manned simulators but are often combined arms exercises. The scenarios are often fixed so pre-experiment modeling is used to gain insight and to focus issues

under investigation during the live experiment. The emphasis is on tailorable MEM.

This presentation concerns new ways the MEM approach is being used in AWEs and some ideas how to further refine the MEM approach to gain insights from relatively few live events. A specific example is given on how MEM can be tailored, to maximize the benefit of closed constructive simulation, interactive simulation and live experiments, for a specific AWE.

Attaining Interoperability between ModSAF and JANUS

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Interoperability between two Distributed Interactive Simulation (DIS) compatible constructive combat models is paramount if they are to participate in the same battle. In 1995, TRAC-Monterey demonstrated with the JLINK project that JANUS can interact with ModSAF using DIS Protocol Data Units (PDUs). JANUS and ModSAF now approach interoperability as the JLINK project supports Experiment IV of the Anti-Armor Advanced Technology Demonstration (A2ATD). This presentation addresses how two disparate combat models can approach the goal of interoperability without changing the fundamental algorithms which drive each model.

JANUS is a discrete event driven model designed to do analysis in a standard non-DIS environment, whereas ModSAF is designed to provide a computer generated force (CGF) for training applications operating in DIS. A very important difference is the degree to which each supports the DIS PDUs. Behaviors of a CGF are another area that play a significant role in the outcome of battles. JANUS does not possess AI based imbedded behaviors, as such there is a high degree of operator intervention during a scenario run. ModSAF provides a friendly force "fill out" and the behaviors negate the need for an operator to constantly intervene is a scenario run. Terrain and the internal algorithms of each model must also be considered when participating in the same battle. The differences in the algorithms include target acquisition, firing procedures, determining the probability of a hit, disengagement criteria, and assessment of a kill. In view of these differences, both models can approach a level of interoperability by ensuring the situation and the settings of particular attributes are equivalent.

Space Play in Theater Models

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This presentation will detail the amount of space representation in several of the more widely used theater level models. The models studied were the Tactical Warfare model (TACWAR), JANUS, the Joint Theater Level Simulation (JTLS), the Integrated Theater Engagement Model (ITEM), the Extended Air Defense Simulation (EADSIM), Thunder, and the ALSP confederation. While the ALSP confederation is not a model but a communication protocol, it was studied because of its future importance in the modeling community. Each model was evaluated according to how each space function and task, as described by the Spacecast 2020 report, is represented. Charts were developed for side-by-side comparison of each model.

Tuesday, 1530-1700
Enhanced Modeling Techniques for Simulation of Evolving Technologies

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The purpose of this paper is to illustrate the versatility of CASTFOREM in its ability to capture the fidelity and complexity of simulating evolving technologies for statistical evaluation. The modeling techniques used to illustrate these are the CR-UAV Target Location Accuracy (TLA) evaluation, the effects of simulating crew coordination in armored fighting vehicles, and the simulation of unmanned ground vehicles in a counter reconnaissance role. Other modeling techniques included: shoot and scoot modeling of MLRS and red artillery; complex battalion, company, and platoon maneuver formations in a movement to contact operation; red air defense coordination and suppression logic; dynamic use of mortar smoke to provide obscuration in open areas and breaching operations during ground maneuvers; and indirect fires on single high priority targets.

These techniques are modeled in Southwest Asia high resolution scenarios. The TLA for the CR-UAV was evaluated by examining a segment of a battle in a high resolution scenario where the aerial vehicles encounter a target rich environment in a FASCAM minefield. Crew coordination modeling includes the search techniques of the commander and gunner, the designation of the target by the commander, the munition selection based on the gun-target range, the type of target, and the characteristics of the fire control system. The unmanned ground vehicles are used to position counter recon forces into battle positions that overwatch the advancing enemy recon elements. Information obtained from the unmanned ground vehicles allow the counter recon elements to maneuver to selected battle positions for concentration of fires on the advancing enemy. The other modeling techniques illustrate tactical operations and maneuvers that required complex decision logic to depict.

Building a Data Warehouse for Modeling and Simulation

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The Joint Data Support System (JDSS) speaker will address the development and implementation of a data warehouse designed to provide information to models and simulations. The discussion will cover key components of the data warehouse architecture to include databases (source and target), data tools (analysis, query, and management), metadata schema (version control, standards, modeling tools, and data dictionary), communications (connectivity, security), and archival capability (for data inputs and study results) required to build the computing infrastructure

and information reservoir to sustain the Joint Analytical Model Improvement Program (JAMIP).

Our approach supports the development of a robust warehouse containing many types of data (forces, performance, logistics, etc.) in a variety of structures and formats. The data store will involve multi-layered filters and translation mechanisms that transform elements from heterogeneous sources into easily accessible "datamarts" accommodating varying degrees of granularity--from the detailed, "primitive" level through aggregate level--and a range of output formats (e.g., object oriented, relational, or flat files). Information (date and meta-data) in the warehouse will be available for ad hoc queries through a "web-like" browser interface.

Our speaker will also touch on joint data support issues dealing with populating the warehouse, implementing data verification, validation, certification and standardization processes, and analyzing the data to develop information tailored to modelers' requirements.

New Strategy for Verification, Validation, & Accreditation

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Verification, validation, and accreditation (VV&A) are essential to establish the credibility of models and simulations in their accuracy to developer specifications, their representation of the real world, and their applicability to a specific purpose. In FY96, the Defense Modeling and Simulation Office (DMSO) embarked on a new, aggressive program to address the VV&A issues in relation to the High Level Architecture and other elements of the Common Technical Framework. The central focus of the strategy is the development of a VV&A Recommended Practices Guide, which will include fundamentals of VV&A, generic VV&A process, strawman procedures, and common reporting formats. The VV&A Technical Support Team will work in conjunction with a newly-formed VV&A Assessment Team (VAT) to provide both technical and programmatic perspectives in developing the recommended practices and assessing them against new and existing VV&A efforts. The Tech Team has been expanded to ensure adequate representation by the Services, academia, and industry, while the VAT includes Service and Joint Staff representation, functional area perspectives, and experience from HLA, DIS, ALSP, and individual simulation applications. The VV&A Technical Working Group, the HLA Technical Support Team, the Architecture Management Group, and participants in MORS Working Group 33 are among the advisory panels whose expertise will be sought to provide additional assessment of the recommended practices guide.

Wednesday, 0830-1000
COMPOSITE GROUP VII SESSION
Bell Hall, Marshall Auditorium

Wednesday, 1330-1500
M1A3 Abrams Main Battle Tank, Bridging the Lethality Gap

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The Russian Army's latest enhanced Armor lethality technology demonstrated in the newest models of their T-80 and T-90 Main Battle Tanks may force the U.S. Army to upgrade its armor program in the next eight years. Russian and Ukrainian armor developments, revealed during and after the Chechnya conflict, include explosive reactive armor (capable of defeating both shaped and kinetic energy rounds), enhanced thermal sights, laser guided ATGMs on T-90s and T-80s, and a mass mounted multi-directional radar that launches munitions against approaching ATGMs and destroys incoming projectiles. The U.S. Army needs to intensify its armor capabilities to defeat the growing number of increasingly lethal main battle tanks available on the open market. Fort Knox requires the next generation Abrams, the M1A3, to extend its fighting capability by 1000 meters (out to 3 km). There are no plans to conduct a major overhaul of its armor program until the middle of the next century. Thus, the Army will upgrade the current Abrams Main Battle Tank to bridge the growing lethality gap between its armored systems and possible threats. The specific design issues include the main gun size (120mm/enhanced or 140mm), the rate of fire, autoloader and ammunition capacity. The 140mm may necessitate decreasing both the rate of fire and the ammunition capacity. How will these modifications impact the combat effectiveness of the tank? We will use JANUS combat simulations, in various missions and terrain, to analyze and predict the combat effectiveness of future alternatives for the next generation tank, the M1A3.

Effects of Simulating Crew Coordination in Armored Fighting Vehicles

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The purpose of this project was to investigate a means of modeling Soviet style armored fighting vehicle crew coordination with more fidelity than what is currently done in the Army's highest resolution model. The crew coordination modeled includes the search techniques of the commander and gunner; the designation of the target by the commander; and the munition selection based on the gun target range, the type of target, and the characteristics of the fire control system. Modified and improved decision table logic within the CASTFOREM combat simulation model was used to simulate crew coordination within the AFV's (tanks and BMPs).

A Southwest Asia high resolution scenario was used to compare the decision logic currently used in CASTFOREM to the improved logic. The more realistic representation of Red (enemy) crew coordination in AFVs resulted in additional detections of Blue (friendly), an increase in the number of shots fired at Blue, the firing of Red anti-tank guided missiles (ATGMs) at longer stand off ranges, and a decrease in Red attrition levels.

Trade Study Analysis Using Training Simulations: Combat Service Support Training Simulation System Case Study

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A major opportunity exists to leverage simulation technology by exploiting the current base of training simulations as analytical tools. It is the intention of this paper to explore the possibility of successfully moving a training simulation from the training domain to the analytical domain. The method of this paper is to consider the question for the Combat Service Support Training Simulation System (CSSTSS) in particular, and to generalize from the specific observations of such a domain shift for one simulation to conclusions that may be applied to the general question of the utility of training simulations and simulators in analytical studies. The paper will cover topics to include:

- Potential applications
- Automation of Scenario Preparation
- Reduction of dependency on human interactors
- Improvement of the user interface for analysts
- Validation of models for analytical use

<u>*Wednesday, 1515 - 1645*</u>

An Evaluation Program for the Intelligent Minefield System

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The mission of the Wide Area Munition (WAM) is to increase the effectiveness of minefields, slow clearing operations by attacking enemy vehicles, and disrupt enemy formations and command and control forward of most direct fire systems. One future concept combines a new generation of WAMS with "dumb" mines to form an intelligent minefield. The intelligent minefield integrates new mine systems into an optimized, logistically efficient, autonomous anti-armor barrier by allowing WAMs to communicate and provide real-time tracking of potential targets. The purpose of this research is to design a system that enables a user to evaluate different characteristics of an intelligent minefield, such as: effective detection range, effective communication range, and the probability of hit for a WAM. Other characteristics that will also be evaluated include the delay time caused by a particular minefield, the effectiveness of a particular minefield pattern, and the cost-effectiveness of a given minefield. The evaluation system is written in Visual Basic and operates on a PC. The user is given full control of the program, to include, designing a minefield pattern by placing mines on the screen through the use of a mouse and associated icons. An optimal minefield pattern, which maximizes the coverage area and communication capabilities of the WAM, is also available for the user. The evaluation program simulates vehicles entering the minefield from different locations, allows for numerous runs, and calculates appropriate statistics including confidence intervals.

Results of USCINCPAC/Naval Postgraduate School Workshop on OOTW Analytic Models

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This paper describes the results of s workshop held in February 1996 on analytical modeling for Operations Other Than War (OOTW). Organized by USCINCPAC and hosted by the Naval Postgraduate School, the primary purpose of the workshop was to establish a road map for developing analytical tools for OOTW. Although many analytical models exist for conventional warfare, and a handful of training simulations are available to assist in OOTW, few analytical models have been designed for OOTW. This workshop was the first step in filling the void.

The workshop consisted of briefings, plenary sessions, and working groups. The end result was two products: joint modeling and simulation requirements, and possible solutions to address the void in OOTW analytical models and tools. Discussions concentrated on operations below a Major Regional Contingency and above normal peacetime engagement. Attendance was limited to a small group of individuals who have either performed applied research in OOTW analysis or who have a need to develop tools in OOTW analysis.

Most experts believe the U.S. military will be conducting OOTW missions with increasing frequency in the 21st century. Analytical tools must be developed to provide OOTW decision makers with a structured process and meaningful data upon which to base their decisions. We believe this workshop provided the basis for significant efforts to develop OOTW analytical models.

Testing of Multitrajectory Techniques for Military Simulations

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Multitrajectory simulation differs from conventional simulation in its treatment of probabilistic events: where one would normally choose one alternative in a simulation replication, multitrajectory simulation creates new states and tracks their trajectories. Thus, while conventional simulations sample the outcome range, multitrajectory simulation attempts to explicitly account for the various alternative outcomes. Management of the possible combinatorial explosion resulting from many events requires careful selection of critical events for multitrajectory treatment, and techniques for classifying states with similar trajectories so that some can be pruned.

In a research project sponsored by the U.S. Army Concepts Analysis Agency and the Army Research Office, Wilkes University has been exploring the issues and benefits of applying multitrajectory simulation to military simulation. A simple surrogate simulation similar (but simpler than) Eagle was developed, with multitrajectory mechanisms for movement, acquisition, decisionmaking, and attrition events. Replications were run allowing the set of outcomes developed with multitrajectory treatment to be compared to the outcome sets produced by random selection for these same events. Two techniques for controlling the proliferation of trajectories have been tested. In one, the simulation resorts to random selection when the number of trajectories reaches the limit that the software environment can handle. In the other, it does this only for the least probable simulations as the resource limit is approached.

Thursday, 0830-1000
Quantitative Analysis of OOTW

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Since the end of the Cold War, OOTW has emerged as a major challenge to the Department of Defense (DoD). Multiple agencies have efforts underway to understand the implications of OOTW with respect to other missions within the National Military Strategy (NMS). The many different types of activities within OOTW may present potentially significant competition for the assets of the DoD force structure, which is designed and resourced to support a two-MRC national strategy. DOD's present capability for assessment of OOTW is limited and consists of mobility and readiness models using non-standard Measures of Effectiveness (MOEs). ODPA&E's OOTW Analysis Project will adapt traditional quantitative analytical techniques for novel applications in evaluating the impact of OOTW on the NMS.

Joint Countermine Operational Simulation (JCOS) After-Action and Reporting System

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The purpose of the Joint Countermine Operational Simulation (JCOS) is to provide an end-to-end advanced distributed simulation capability for joint mine/countermine (MCM) operations from sea to land. The JCOS will demonstrate the value of employing new and existing countermine technologies, tactics, techniques, and procedures to provide elements of a joint task force the capability to minimize the impact of a combined sea and land mine threat. The JCOS provides the underlying simulation capability supporting the Joint Countermine Advanced Concept Technology Demonstration (ACTD).

The JCOS After Action Reporting System (AARS) will support evaluation, analysis, and performance assessment supported by audio and visual aids. The AARS will consist of several components that facilitate exercise preparation supporting training or analysis objectives, provide real-time monitoring and scanning with 2-D tactical map displays and 3-D "stealth" visualizations of the battlespace, compile exercise data, and permit statistical analysis using both established and customized measures of performance (MOPs) and measures of effectiveness (MOEs).

The data collection and analysis components of the AARS will consist of three major subsystems: a COTS relational database used as the primary AAR data repository; data logger/loader agents which will capture simulation network traffic, filter and parse the individual messages, stage relevant data at each site, and forward the data to the AARS repository; and a COTS World Wide Web (WWW) browser. The browser will provide the download a variety of data directly to desktop applications such as spreadsheets and presentation graphics products.

Developing Criteria for Operational Interfaces for Senior Level Professional Military Education War Games

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Computer assisted war games have been used in professional military education with some success. One advantage is the possibility of reduced labor requirements during the execution of simultaneous independent exercises. However, computer assisted war games for educational purposes, to date, use a "bottoms-up" approach and becomes too tedious for students who, at their 18th to 22nd year of military service, need war game exercises at a higher--more aggregate--level. The Air War College in conjunction with the Air Force Wargaming Institute has embarked on establishing the "right" levels of information needed by students to analyze, synthesize and evaluate the higher levels of operational art in warfare. This paper describes our view of educational war games, the use of technology in educational war games and attempts to identify inputs at the operational level.

Thursday, 1330-1500
Extending Air Defense into Vector-in-Commander

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In an effort to improve the functional representation of air defense in our models and simulations, the TRADOC Analysis Center (TRAC) has integrated Extended Air Defense Simulation (EADSIM) into our Corps/Division level model, Vector-In-Commander (VIC). The VIC Model is a two-sided deterministic simulation of combat in a combined arms environment. The model design provides a balanced representation of major force elements in a tactical campaign of a U.S. Army Corps, with a comparable enemy force, in a mid-intensity Theater of Operations. EADSIM is a stochastic, analytical model of air and missile warfare used for scenarios ranging from few-on-few to many-on-many. The main thrust of this paper is to educate and inform the

reader in the types of modeling problems they may encounter when linking EADSIM with other models.

The paper discusses the problems encountered in the modeling process, the methodology for finding and correcting these problems, and the process used for linking the deterministic and stochastic models. The paper also discusses enhancements to the VIC/EADSIM linkage that improve our ability to model details. The enhancements include: dynamic targeting, attack operations, early warning, joint operations, and TBM effects on early entry scenarios.

Ardennes Campaign Simulation

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The Ardennes Campaign Simulation (ARCAS) study was performed to improve the credibility of the Stochastic Concepts Evaluation Model (STOCEM) simulation by comparing a STOCEM simulation of the WW II Ardennes campaign of 1944-45 with historical campaign results. Historical campaign data had been developed, from archival sources, in to a computerized data base denoted as the Ardennes Campaign Simulation Data Base (ACSDB). The initial positions, configuration, strengths, compositions and availabilities of forces for the campaign, as depicted in the ACSDB, were used to define the STOCEM force laydown for ARCAS. Simulation results (front line movement, major system losses, and casualties) are compared with historical results from the ACSDB. Stochastic variability of average model outcomes is also quantified in terms of confidence limits and bounds. The comparison of simulation results with history is used to develop guidelines for algorithmic changes which improve model credibility of STOCEM. Insights on model verification and validation (V & V) are also developed. Findings include :

- ARCAS shows tendencies to generate more movement, system losses, and personnel casualties than history.
- Changes to STOCEM logic/inputs suggested by the comparisons include:

(a) Modified logic to simulate a breakthrough attack posture generating accelerated defender systems attrition and personnel casualties, related to attacker speed and overwhelming force advantage.

(b) Moderation of attacker move rate in response to a sustained rapid combat advance. Reductions in attacker move rate inputs.

(c) Reduction of an attacker's base ARCAS STOCEM lethality against enemy tanks and APCs, especially under high strength advantage.

Representing Information Warfare in a Corps Level Combat Model

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Of the three types of combat simulation, virtual, real, and constructive, only constructive simulation is as widely used and well understood with respect to its valid uses for analysis of combat operations. Therefore, as simulation technology grows more exotic with the development of distributed interactive simulation, traditional constructive combat models are likely to remain a very important tool for analysis of force structuring, combat developments, contingency planning, and many other issues.

At the same time, it is widely believed that the very nature of combat is changing because of the impact of information technology. But representation of information warfare in constructive models is not fully developed, especially in aggregate models. It is imperative, therefore, that continuing research be conducted aimed at better representing combat operations of the future.

Work being done at United States Army Concepts Analysis Agency using the combat model Eagle is addressing the representation of information warfare at the operational level of combat. The effects of digital sensor-to-shooter links, intelligence fusion, command and control technology (specifically the Army Tactical Command and Control System or ATCCS), and digitization of the battlefield were all modeled in Eagle scenarios used to support the biennial capital budgeting study, "Value Added Analysis." In this presentation, the schemes for representing these various information warfare functions are discussed.. This first use of Eagle in a major analytical effort demonstrated that Eagle promises to be a useful tool for understanding the future of combat operations in the context of Force XXI initiatives and issues.

ALTERNATES

Lessons Learned and Applied in Building an ADS Infrastructure

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Building an Advanced Distributed Simulation (ADS) is an extremely complex process for which no guidelines currently exist. The Modeling and Simulation community is rapidly gaining insight into the ADS structure building process through experience in planning, organizing, and conducting several large ADS exercises. Experiences have ranged from "very good" to "very bad" with no one area of the process escaping serious pitfalls. This presentation will summarize the experiences encountered by TACCSF as a participant in several ADS projects into lessons learned. The application of these lessons learned to the Warfighter 95 exercise will also be covered. The specific areas of the ADS process covered by this presentation are:

Planning (Key to success)
System Engineering
Connectivity
Communications Security
Scenario Development
Data Collection and Analysis

JETTA -- Is DIS Ready for the Analyst?

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The Joint Environment for Testing , Training, and Analysis (JETTA) project was sponsored by the Defense Modeling and Simulation Office to establish a simulation and data collection network, architecture, and tool set capable of linking live, virtual, and constructive simulations in a Joint virtual battle space. The JETTA distributed simulation network included:

- the Naval Command, Control, and Ocean Surveillance Center RDT&E Division;
- the JTIDS System Integration facility;
- the Naval Air Weapons Division Battle Management Interoperability Center and Weapons tactics and Analysis Center;
- the National test Facility;
- the Tactical Air Command and Control Simulation Facility;
- the Theater Battle Arena;
- the Depth and Simultaneous Attack Battle Lab; and
- the Boeing Space and Defense Division.

The JETTA program was successful in integrating Joint distributed simulations and real systems using DIS protocols and in providing an effective simulation of the Joint Warfare environment.

This presentation will cover the current state of the JETTA network to provide accurate and timely data collection on critical events to facilitate analysis of performance and effectiveness of Joint operational concepts or systems. Both network and operational performance measures will be addressed from the perspective of an air warfare analyst.

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Alphabetical Index of 64th MORSS Presenters

Schedule for the 64th MORSS

Tuesday, 18 June 1996

0645	0900	Registration—Bell Hall
0715	0815	Working Group Chairs/CoChairs Warm-Up—Marshall Auditorium, Bell Hall
0830	1000	**Plenary Session—Eisenhower Auditorium, Bell Hall**
1030	1200	1st Working Group Session and Composite Group II Session
1200	1330	Tutorials
1330	1500	**Special Session #1**
1530	1700	2nd Working Group Session and Composite Group I Session
1715	1900	Mixer—Frontier Crossroads Club

Wednesday, 19 June 1996

0700	0800	Town Hall Meeting (WG & CG Chairs)—Frontier Crossroads Club
0830	1000	3rd Working Group Session and Composite Group VII Session
1030	1200	**Special Session #2**
1200	1330	Tutorials
1330	1500	4th Working Group Session and Composite Group III Session
1515	1645	5th Working Group Session and Composite Group VI Session
1830	2130	Western Barbecue—National Agricultural Center and Hall of Fame

Thursday, 20 June 1996

0830	1000	6th Working Group Session and Composite Group V Session
1030	1200	**Special Session #3**
1200	1330	Tutorials
1330	1500	7th Working Group Session and Composite Group IV Session
1500	1530	Working Group Chairs/CoChairs Wrap-Up—Classroom 6, Bell Hall
1530	1700	**Special Session #4**